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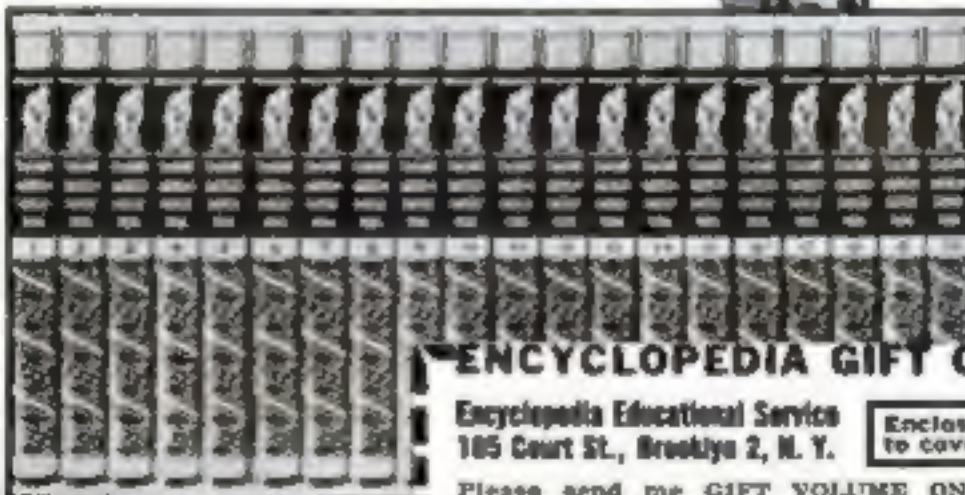
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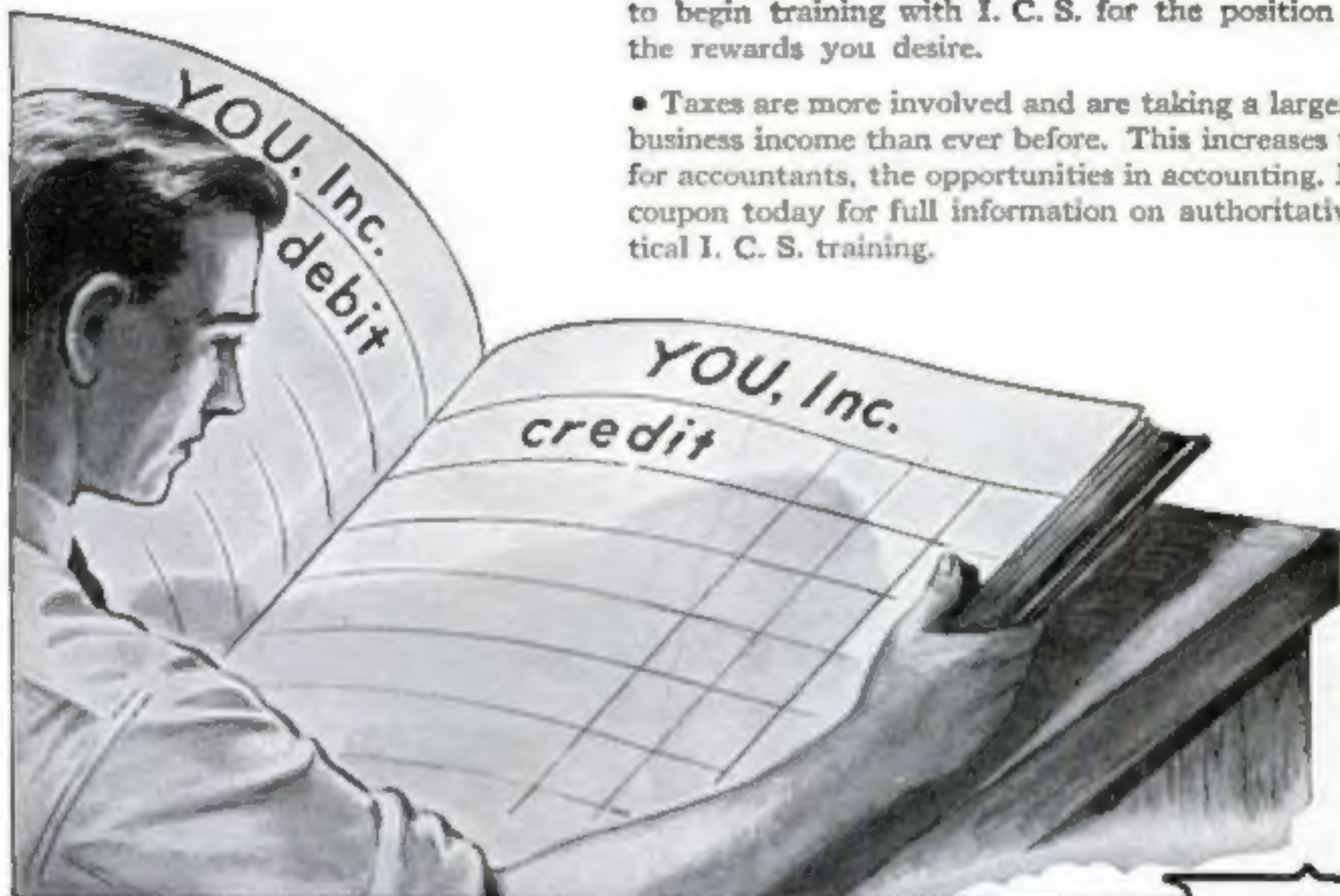
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VOL. 144 NO. 4

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

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Kodachromes on cover: Photograph of landing boat is from the Army Signal Corps. Aerial photograph is from the Army Air Forces. The silver ink on the cover is prewar stock.

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STEWART ROUSE. We think it's high time we presented a man whose drawings are an outstanding feature of this magazine. Rouse studied at the Chicago Art Institute, has been a staff artist for P.S.M. since 1933, and stands six feet three in his socks. Characteristic of his fine work are the drawings on pages 59 and 68-69 of this issue.

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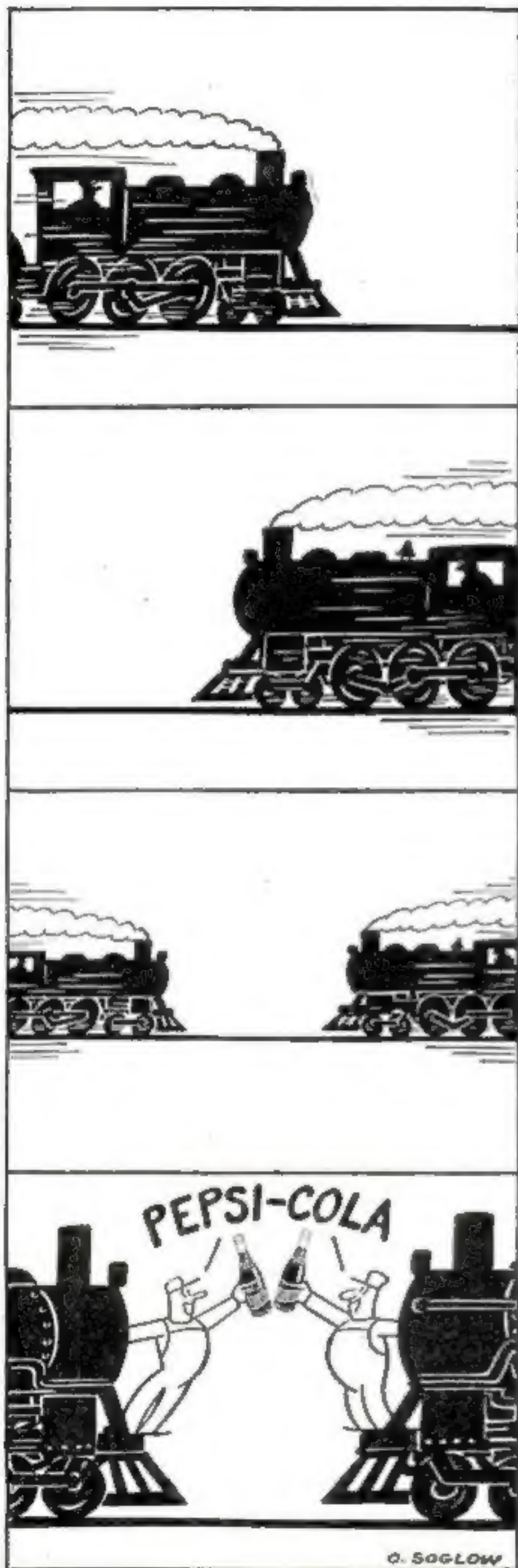
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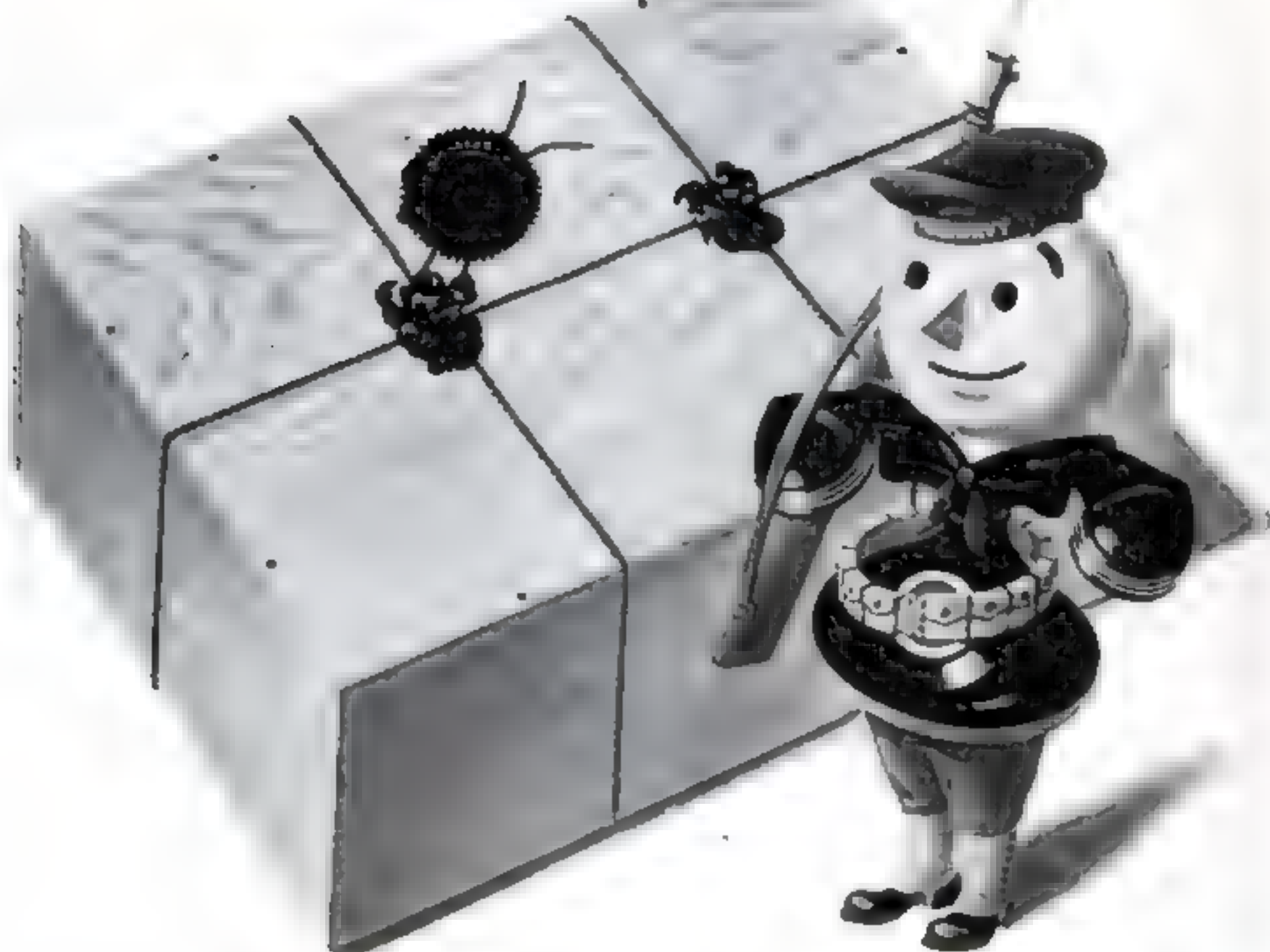
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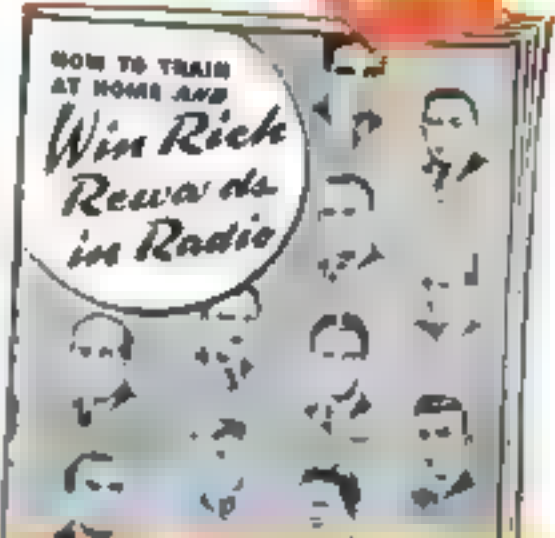
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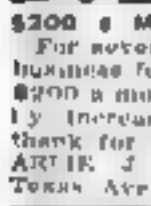


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WERE the great personages of the past victims of a stupendous hoax? Could such eminent men of the ancient world as Socrates, Pericles, and Alexander the Great have been deluded and cast under the spell of witchcraft—or did the oracles whom they consulted actually possess a *mysterious faculty of foresight*? That *the human mind can truly exert an influence over things and conditions* was not a credulous belief of the ancients, but a known and demonstrable fact to them. That there exists a wealth of infinite knowledge just beyond the border of our daily thoughts, which can be aroused and commanded at will, was not a fantasy of these sages of antiquity, but a dependable aid to which they turned in time of need.

It is time you realized that the rites, rituals and practices of the ancients were not superstitions, but subterfuges to conceal the marvelous workings of natural law from those who would have misused them. Telepathy, projection of thought, the materializing of ideas into helpful realities, are no longer thought by intelligent persons to be impossible practices, but instead, *demonstrable sciences*, by which a greater life of happiness may be had.

One of America's foremost psychologists and university instructors, says of his experiments with thought transference and the powers of mind—"The successes were much too numerous to be merely

lucky hits and one can see no way for guessing to have accounted for the results." Have you that open-minded attitude of today which warrants a clear, positive revelation of the facts of mind which intolerance and bigotry have suppressed for years? *Advance with the times; learn the truth about your inherited powers.*

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IF YOU want powerful muscular development that just shouts vigor and vitality, then look at the pictures of the two fellows shown at the right. They, too, were fed up with being weaklings, with flabby, skinny muscles. They were sick of being **HALF ALIVE**. So they wrote for my free book and followed my instructions. Now look at them!

I, too, was once a 97 lb. weakling, ashamed to strip for sports or swim. But later I discovered the secret that turned me into "The World's Most Perfectly Developed Man." And now I'd like to prove to you that the same system can make a **NEW MAN OF YOU!**

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INVENTORS

NOW Is the Time to PATENT and SELL Your Invention

Now, more than ever before, is the right time to patent your invention. Why? Because manufacturers everywhere presently engaged in war production are looking ahead to the future by buying up patent rights now, so they will have new and attractive items to make and sell for civilian consumption as soon as the war is over. This is what happened during and after the last war. Hence, the smart thing for you to do is to look ahead to the future too. Protect your invention by applying for a patent now, so you will be in position to cash in on an outright sale, or on the royalties your invention will bring.

Patent Guide Shows What To Do

Our "Patent Guide for the Inventor" answers many important questions concerning Patents that inventors constantly ask. It tells what facts, details, drawings, sketches, etc., are necessary to apply for a Patent; how to protect your invention through dated and witnessed disclosure; how to do this AT ONCE to safeguard your rights; how Patent Office Records can be checked to determine whether the invention is probably patentable before filing fees need be paid; discusses costs involved and a practical way these can be paid as the application progresses. It tells how some inventors secured financial backing; how many simple inventions have proved large commercial successes; how Patents covering improvements also can be profitably utilized and marketed; tells countless other facts of interest.

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The Patent Laws were enacted for your benefit—to give you protection for the features of your invention which are Patentable. But these features must be legally and concisely set forth in the form of "claims." This phase of the procedure is so complex that the Patent Office advises the Inventor to engage a competent Registered Patent Attorney. We maintain a large staff—carefully trained registered patent attorneys—expert draftsmen—experienced searchers—to serve you. We have been serving inventors for more than 20 years.

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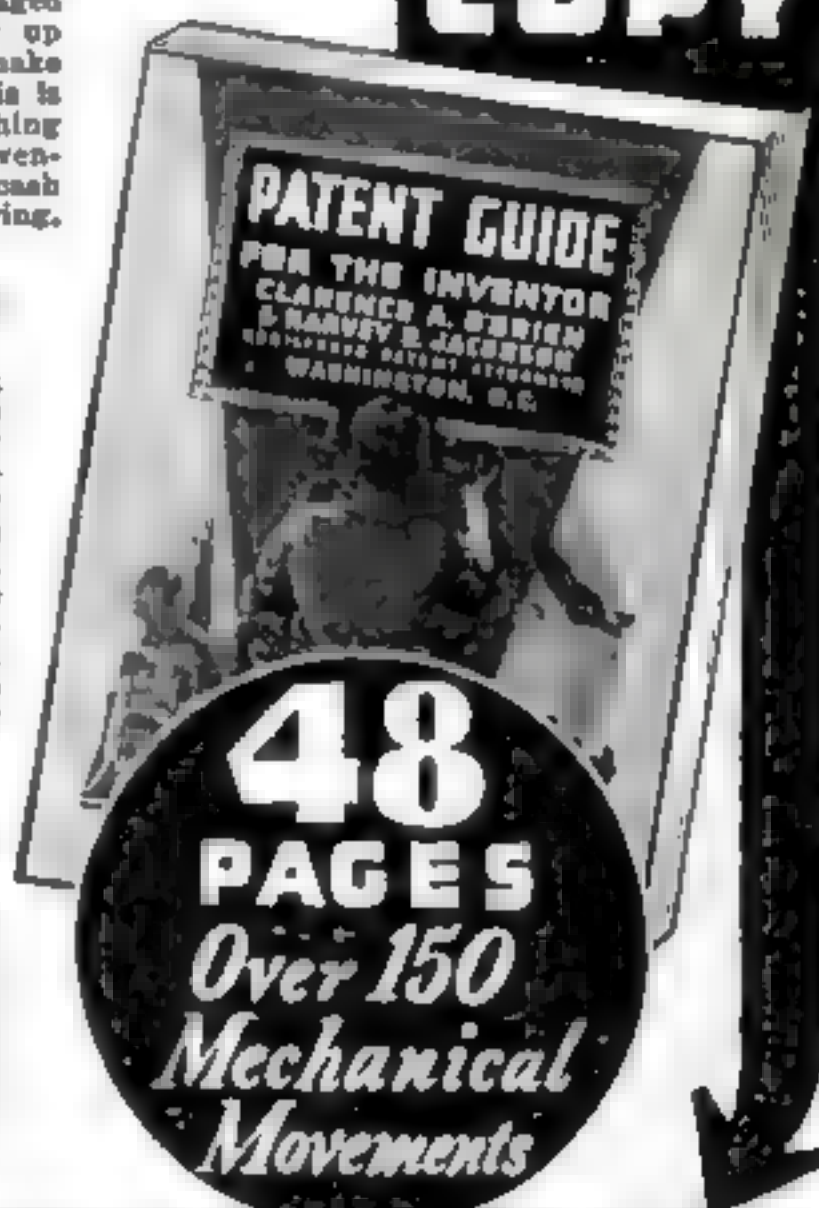
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Fifteen-year-old August Holland, of Mendota, Ill., painted this picture of a U. S. Army tank in action

Artist Has "One-Man Show" in Readers Say

I HAVE often admired the drawings and paintings in your magazine. I am sending you a painting of my own, showing an American tank in action. I am 15 years old and I like to paint very much. I would be very happy if you could use my painting in P. S. M.—A. H., Mendota, Ill.

We're very glad you thought of us, A. H. Unfortunately, we have no editorial material scheduled with which we can use your painting as an illustration, but we think it is fine work and are glad to show it here.—Ed.

Wants a Reference Chart of Japanese Insignia

MY SON, who is overseas, recently sent us some insignia that he had taken from the uniforms of Japanese soldiers he had killed. The son of my friend next door did the same thing for his family. Now our younger children are constantly fighting with each other over who holds the higher-ranking insignia. What I would like to see in your magazine is a Japanese insignia chart. Many Americans are receiving these emblems, and I'm sure they would like to know just what they signify.—J. S., Perth Amboy, N. J.

Front Stop Light Has Been Shining Since 1934

IN THE February issue, F. E. L. suggests a front stop light as a means of promoting safer driving and of letting pedestrians know whether the driver of a car intends to stop or to continue moving. I have used such a stop light since 1934 and I have found it to



be a fine safety device. I have been surprised to find that pedestrians catch the meaning of a front stop light even more quickly than do the drivers of other cars. As I approach an intersection, I can see people on foot hesitating about crossing in front of me. Yet the minute I apply the brakes and the front light flashes, they seem to know that I intend to stop.—E. S. C., Kansas City, Mo.

Would Like to Put His Hobby into Uniform

YOUR article in the January issue, "They Bring 'Em Back Afloat," hit me just right. Before the war my hobby was building small boats, sinking them, and then trying different methods of raising them. I think I have developed some methods that would save a lot of time and money. I would like to know to whom I should write in the Navy so that I may offer them.—J. L. S., Monrovia, Calif.

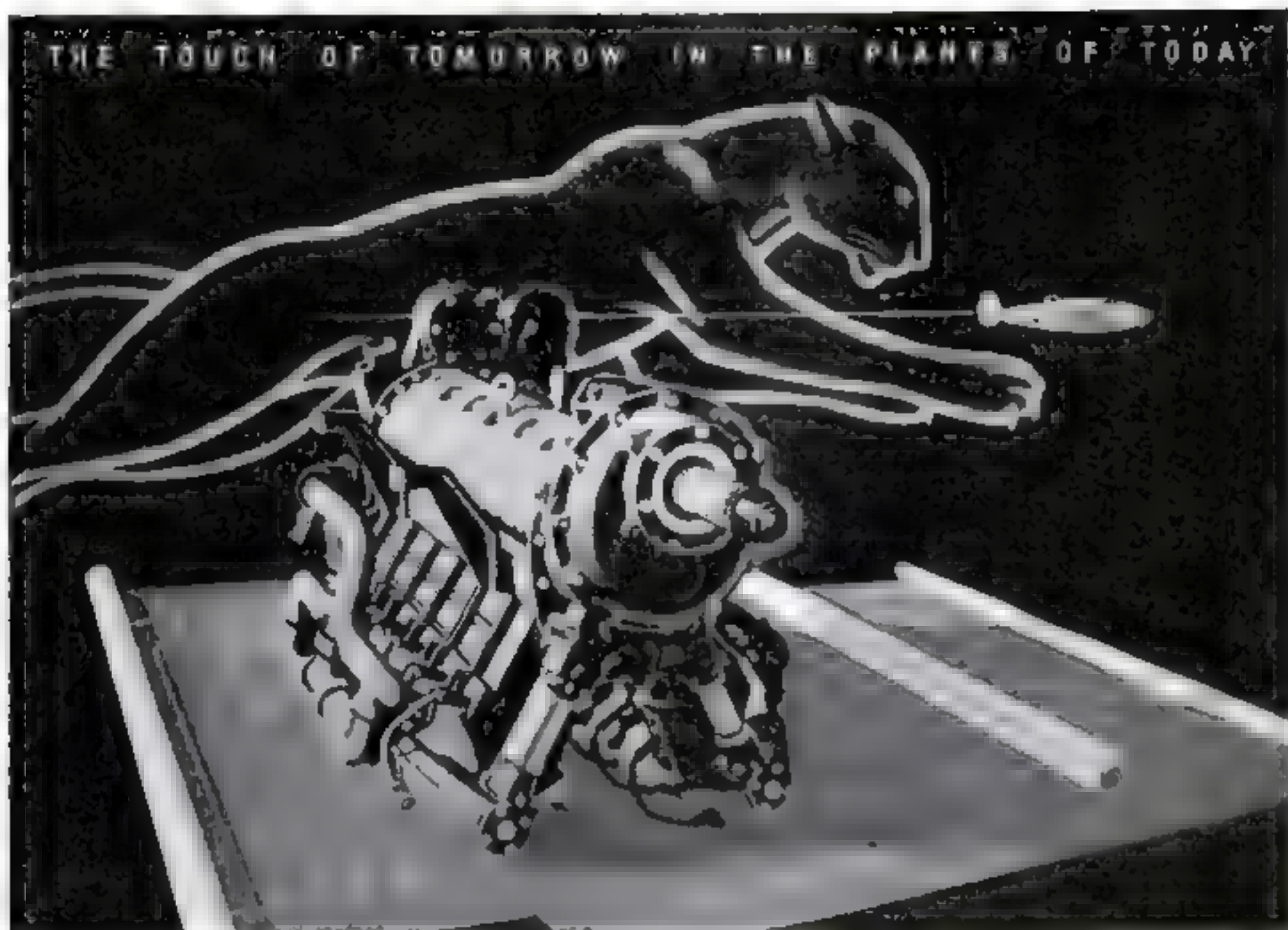
You'll find your answer in the letter titled "New Enlistment Center for Ideas and Inventions" in the March issue.—Ed.

Crab Has Man-to-Man Talk with Magazine

BEING a miserable old crab of 26, I want to talk to you man-to-man. I don't really expect to see this letter in print, yet I and 10,000 other crabs would like to see you publish it. What has made all these crabs? Well, I'll tell you. What incarnation ever happened to the scale ship models that you used to run? These crabs buy your magazine each month, hurriedly thumb through it, and then with tears in their eyes they turn the last page without seeing a single plan for a scale ship model. By this time they are softly cussing to themselves as they see all the space that has been given to the bathroom chemists and camera worms. There always seems to be space for some jerk who likes to blow soap bubbles or tell you how to wiggle your toes and ears at the same time.—F. W. R., Syracuse, N. Y.

YEAH, HOW'S ABOUT
SITTING IT?





Purr of a Kitten - Power of a Panther

The panther is unique in many ways. It packs more lightning power in its small, lithe frame than many animals of greater size. Much the same can be said of the 550 horsepower Ranger aircraft engine.

The Ranger is the *only* in-line, inverted, air-cooled engine in production in America. Its sleek lines and narrow nose permit it to slip through the air with a minimum of drag, and in addition, give the pilot greater visibility.

It is "lighter and quicker on its feet" than other engines in its power class . . . delivers more power for its weight.

And then, it stands alone in still another respect: it is the one truly high-speed en-

gine in its power class. The explosions that give life to its parts recur with such lightning rapidity that they blend into a velvety purr.

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OLD POP SCIENCE SURE GOT ME UP IN THE AIR!



Suggestions Would Be Gratefully Received

I AM unemployed because I could not find any means of getting to my job, which was 30 miles away. I was working as a draftsman, but I can do mechanical work if it does not require a lot of electrical equipment. I would appreciate suggestions as to how I could find some sort of work that could be done right here in my own home and at the same time help out in the war effort.—J. D. W., Robertsedale, Ala.

Sorry That We Couldn't Publish It Sooner

I HAVE always wanted to be an engineer, but owing to improper dental information, I cannot enter any college-training program. Why don't you publish an article that tells your readers the truth about dental care?—R. M., Columbus, Ohio.

THIS IS NO JOKE



Thanks, R. M., for giving us this opportunity to tell our readers that we have just such an article scheduled for publication in the very near future.—Ed.



Can this happen to YOU?

It was the President talking—telling George that while he would like to give him the job—to promote him to an executive position, it was impossible to do so.

This was a bitter blow to George—he had known for some time there would be a vacancy in his department—the department manager was moving up—a new department head would be appointed. By seniority George was entitled to the job, had been counting on it.

It would mean more money—those unpaid bills would be taken care of—the children would have more advantages—there would be travel, recreation, social activities.

George had been a fine, loyal employee for twelve years—doing his assigned tasks well—hoping by faithful service to win some day an executive position with his company.

Now all of these hopes were being swept away—as in a dream he heard his chief continue—"You see, George, in these days it is ability to produce that counts. You're not ready to take on the bigger job—you have made no preparations which would enable you to fill it properly. The man who is going to get that job is Martin. He has been with us only four years, but during that time he has not only been studying the relationship of his department to

the business as a whole, but he has been studying and preparing himself at home."

Poor George—no one to blame but himself. Business is full of "Georges"—men who do not realize the importance of preparing definitely for promotion. They forget that long experience on one job does not necessarily prepare them for the job above. And almost never do they reach the executive job and the bigger money.

Fortunately, there is a way—simple, practical, thoroughly proved by thousands—for the "Georges" to make sure of promotion. Modern home study—the LaSalle way—gives them rather quickly the knowledge and ability to handle the job ahead. It does not interfere with their present job—instead it helps. It is moderate in cost and intensely interesting.

In fairness to yourself—

If you are one of the men in business doing routine work—going along in a low pay job, there is one thing, in fairness to yourself, you should do right away—and that is—**FILL IN AND MAIL THE COUPON BELOW AT ONCE.** It can be the turning point in your business career toward the bigger rewards business is willing to pay to the man who is trained. Our **FREE** booklet **"TEN YEARS PROMOTION IN ONE"** is most inspiring. Don't let a postage stamp and one minute stand between you and full details regarding our training and opportunities to which such training leads.

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Present Position.....

Address.....



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IN THE February Readers Say, C. E. H. asks if anyone knows of a good way to thaw out frozen pipes. The answer is verily yes, and all credit is due my wife—who, by the way, each year presents me with a new subscription to P. S. M. Last winter we had a pipe freeze up from the main line on the outlet side of the meter for a distance of 15 feet. I tried and tried to thaw it out with a plumber's torch when, lo and behold, my wife suggested using our electric heating pad. Believe me, it worked to perfection. Before applying the heating pad we wrapped a clean piece of paper around the $\frac{1}{4}$ -inch pipe so as to prevent the pad from becoming soiled. Hope this will help other readers. Incidentally, I don't mind the boost to 25 cents a copy.—M. A. C., Bloomfield, N. Y.

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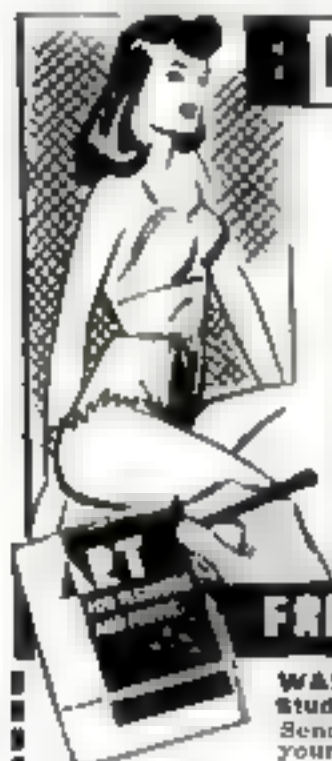


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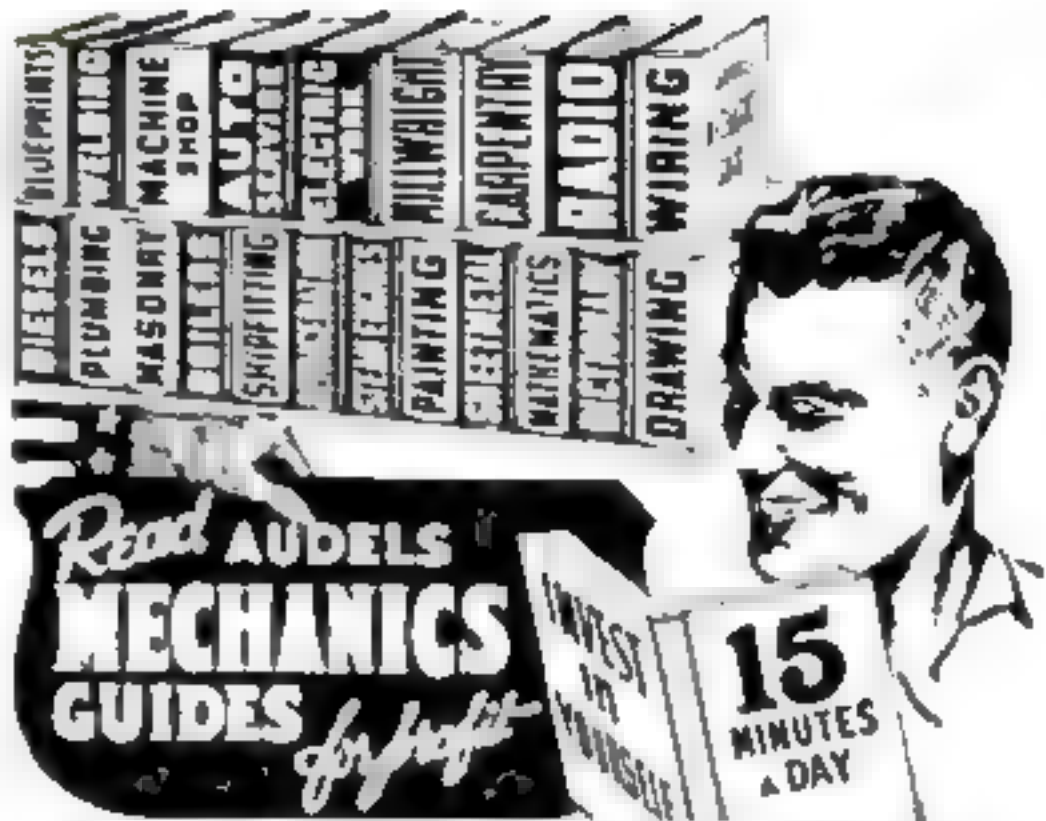
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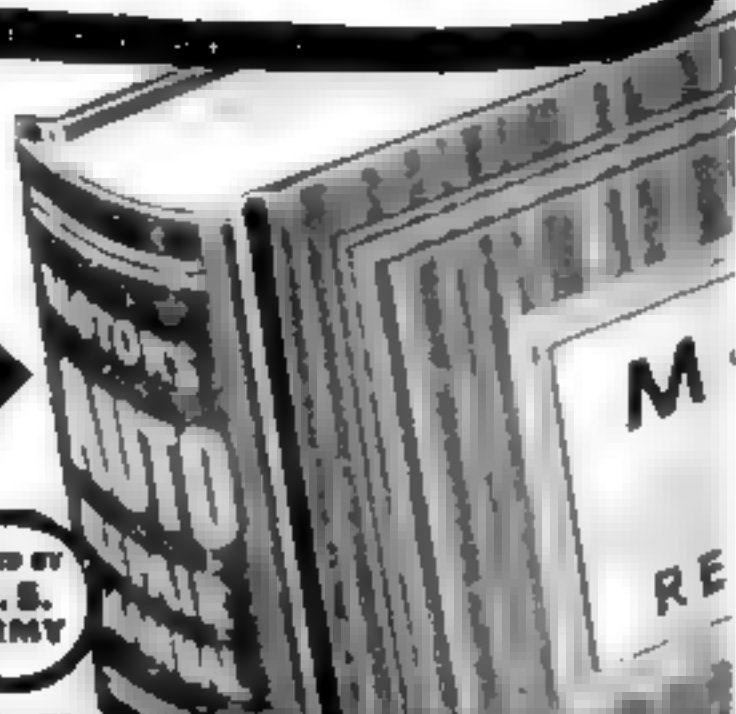
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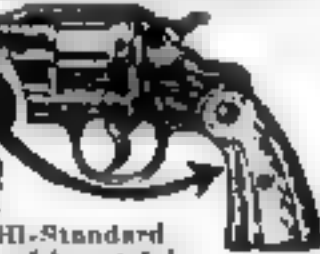


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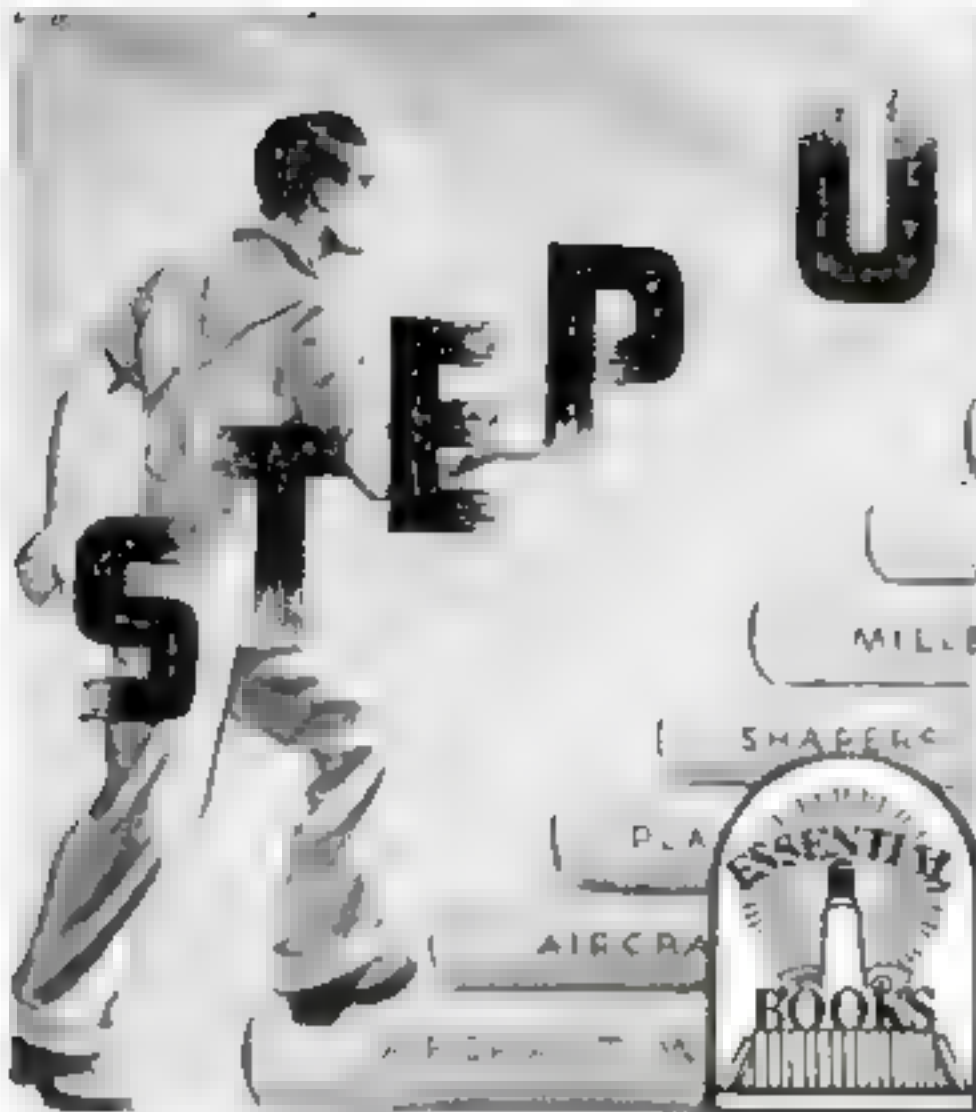
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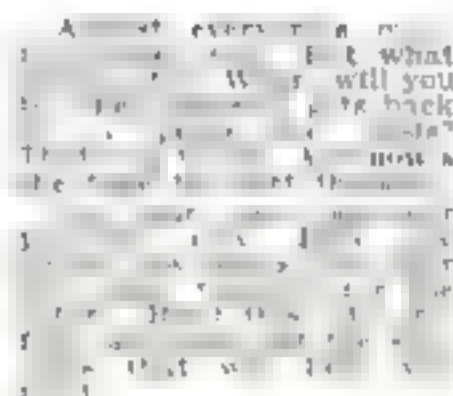
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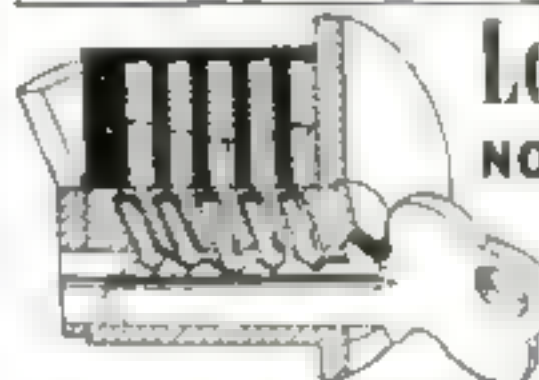
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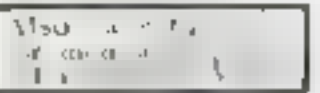
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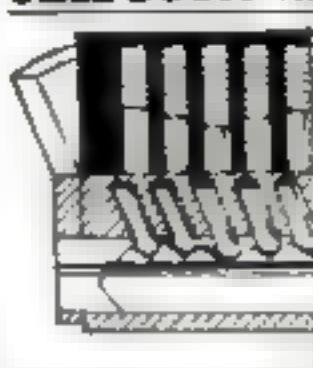
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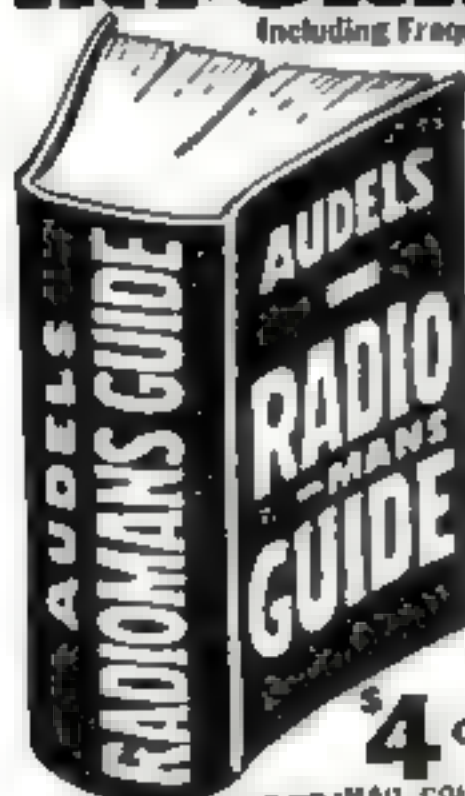
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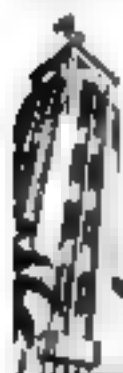
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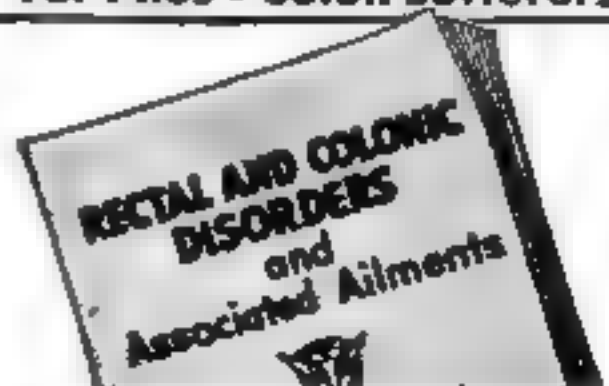


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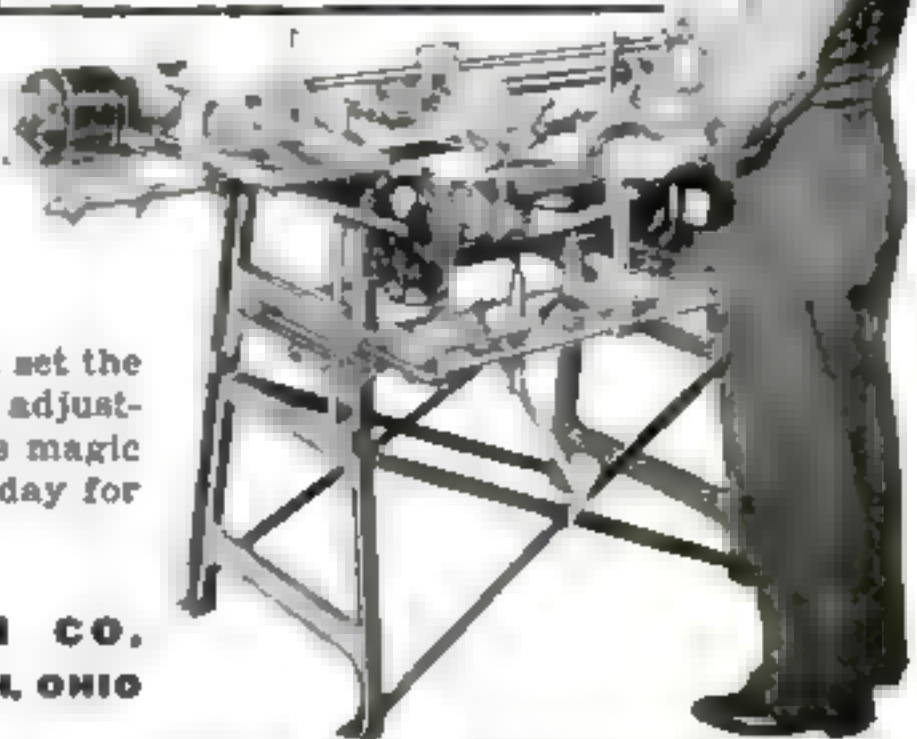
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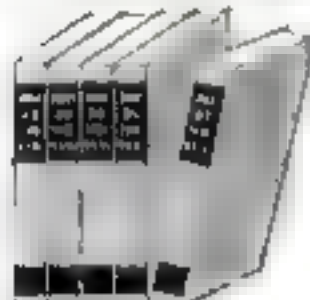
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CHASING ECHOES

on a Destroyer Escort

Every alarm isn't a U-boat, but the lads who man these new watchdogs of the convoys aren't taking any chances.

By HICKMAN POWELL
and HAROLD KULICK

Popular Science War-Front Reporting Team

BOB DENNISTON took his clothes off only to bathe, and once when he got himself well lathered up for a shower, the bell-clanging call to battle stations sent him racing to the flying bridge clad largely in soapsuds. I have seen him at 3 a.m.—his necktie neatly tied, of course—running around with one foot bare, because in the dark he had jumped into his roommate's outsize clodhoppers and lost one in the mad scramble up the ladders. Out of all the wakeful ship's company, Lt. (j.g.) R. P. Denniston was the one who seemed to get



SKIPPER of the DE, Lt. R. H. Stevens, USNR, at action post in middle of the flying bridge



ANTI-SUB officer, Lt. Bob Denniston manages the detection devices and depth charges when hunt starts



OBSERVER aboard is Commander R. N. Norgaard, on his way to duty as commodore of a DE division



ENGINEERING officer, Lt. Claude L. Corbus, is only regular Navy man among officers



NAVIGATOR and executive officer is Lt. Martin Victor. Before the war, he was with a New York law firm



COMMUNICATIONS officer, Ensign Henry A. Huettner, is a former inspector for Labor Department

almost as little sleep as the captain himself.

As a mere j.g., Bob was outranked several times in the wardroom; but as the anti-submarine officer, at the ominous cry of "Bearing clear!" he was the work. The gadgets were his to handle; his was the ear delicately attuned to a faint detecting echo:

and, just in case the alarm was real, from his station topside he picked the pattern of depth charges, and he gave the signal to roll the cans off the stern and let the K-guns go to port and starboard. A continuous alert, a tough, edgy job—but a real one.

This was the maiden voyage of DE 675, one of the new destroyer escorts which have been turned out by mass production to increase convoy protection and perhaps to relieve some destroyers for bigger surface battles elsewhere. No one aboard had tasted blood yet; save the exec, who had a tin can shot out from under him in the South Pacific. But everyone was hot on the trail, and on the way home, I believe, they got their chance at a U-boat.

The best contact we had on this trip—if indeed it was a sub and not a school of fish—came two days before we made our landfall. The destroyer on the left wing caught it first; then we picked up an even



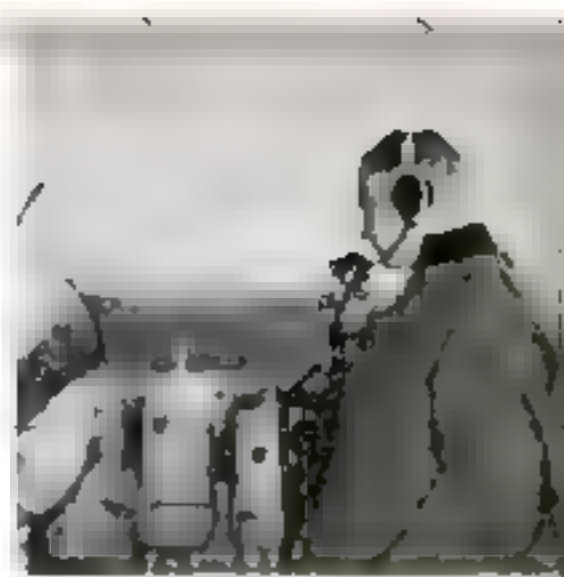
ONE STACK does the work of two, saving deck space on the little DE. Though the ship has two boiler rooms, one funnel serves them both. Fumes from the forward room are carried by forced draft through an almost horizontal flue to the stack



SUPPLY officer, Ensign R. G. Cohen, sees to it that the DE crew has what it needs for both living and fighting



SOUND-DETECTION hut is manned by Ensign David Acheson, peacetime specialist in 18th century literature



GUNNERY officer, Ensign Charles A. Stecker, has a welcome for foes in air, on sea



SECOND IN COMMAND is Lt. B. A. Swenson. He hails from Houston, Tex., is an architect in civilian life

CREW MEMBERS, boys from farms and shops and schools all over the country, find relaxation and sociability when off duty in the cramped quarters below. For many of them, this was the first real sea voyage

stronger echo on the detector.

"Check bearing!" came the cry from the sound hut. And an officer on the bridge, squinting through the pelorus along the precise compass bearing from which the echo came, cried: "Bearing clear!"

Strangely enough, if he had said "Bearing foul," that would have been calming news. It would have meant that on the surface something was seen, presumably explainable. "Bearing clear" meant that he saw only an expanse of blue water. Under the surface something was reflecting our sound beam, and it might not be a whale.

The admiral commanding told us on the short-range radio to cut loose and track it down. In this convoy were big troop transports and gasoline tankers. Running interference were some destroyers and our DE.

Dropping back on the scent, the DE be-



gan cutting circles. This was her first chance to do her stuff.

Bob Denniston was doing the conning. He had been late to lunch that day, but the messboys had saved him a chunk of steak. The ensigns had been waiting around for him to give them an afternoon lesson in trigonometry and other mathematics of sub detection. Bob had just cut and forked his first big bite of red, rare, prewar-quality beef, when the call came that he was wanted on the flying bridge. That boy was always being interrupted in something. He went flying, but even before he got there the captain had clanged the bell for general quarters.

Everybody was (Continued on page 56F)



FLYING BRIDGE is nerve center of the ship in action. From this exposed perch, in all kinds of weather, officers direct the hunt for U-boats



WHEELHOUSE. Gyrocompasses and other modern navigating aids help the helmsman to hold his course. Convoy work calls for close co-ordination

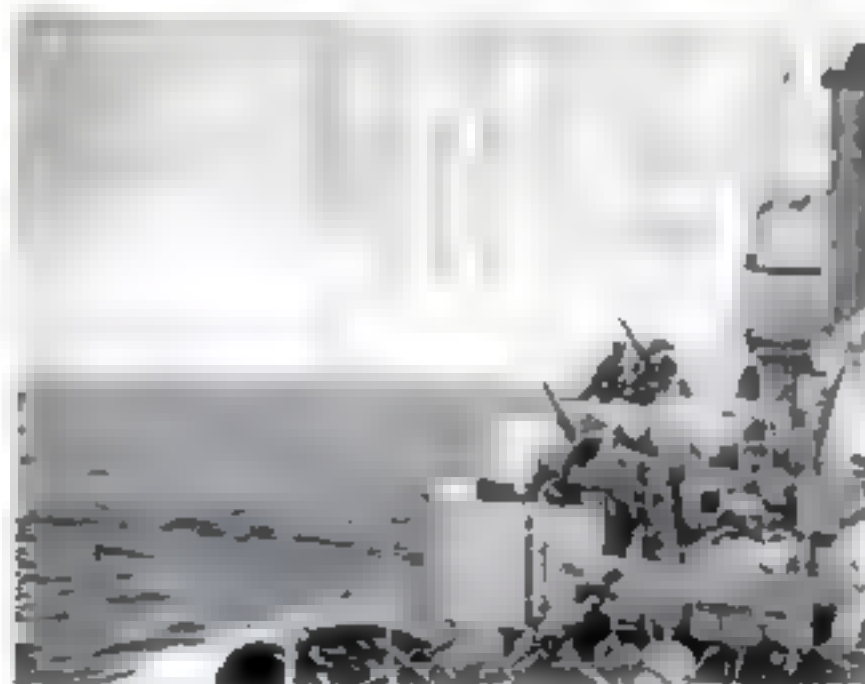


BOW of the DE has a flaring design that throws back the seas and keeps her from shipping too much water. Even so, there is plenty of flying spray, even on the exposed bridge, when waves run high



GARBAGE can't go over the side, even to leeward, in the daytime. The telltale wake would give away the nearness of the convoy to eager enemy eyes. So refuse is kept aboard, on the fantail, until night

GUNS guard the DE against planes and surface craft. Forward armament, seen below, consists of three-inch guns and 20-mm. antiaircraft cannon



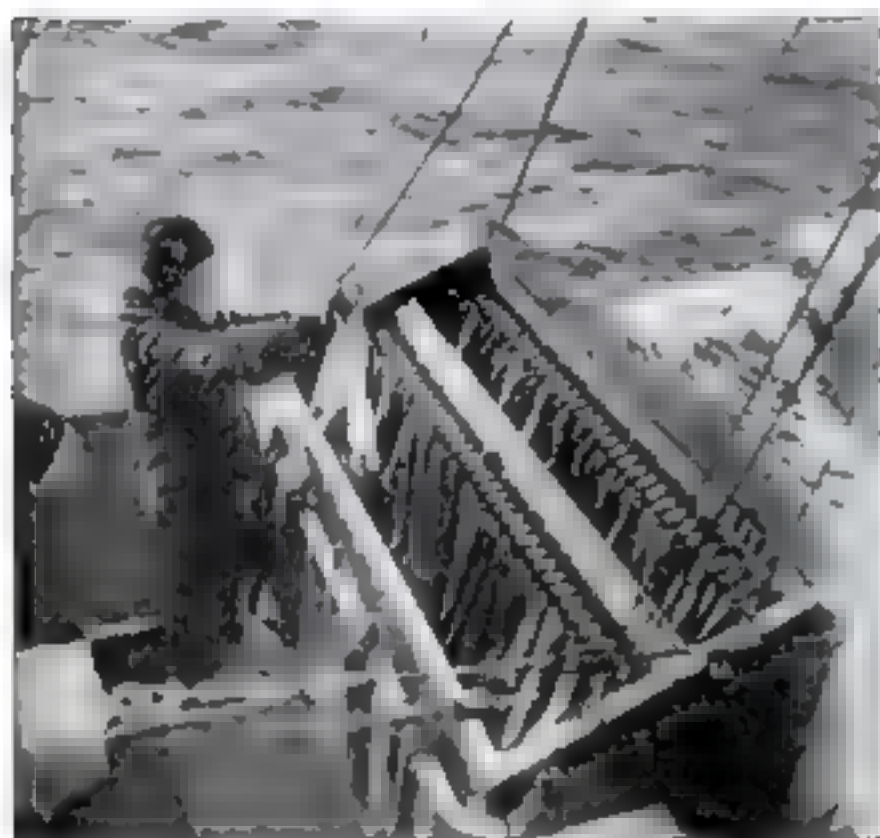
PRACTICE firing keeps the antiaircraft gunners' hand in. Here the 20-millimeters on their "bond-stands" are blazing away at imaginary enemy planes



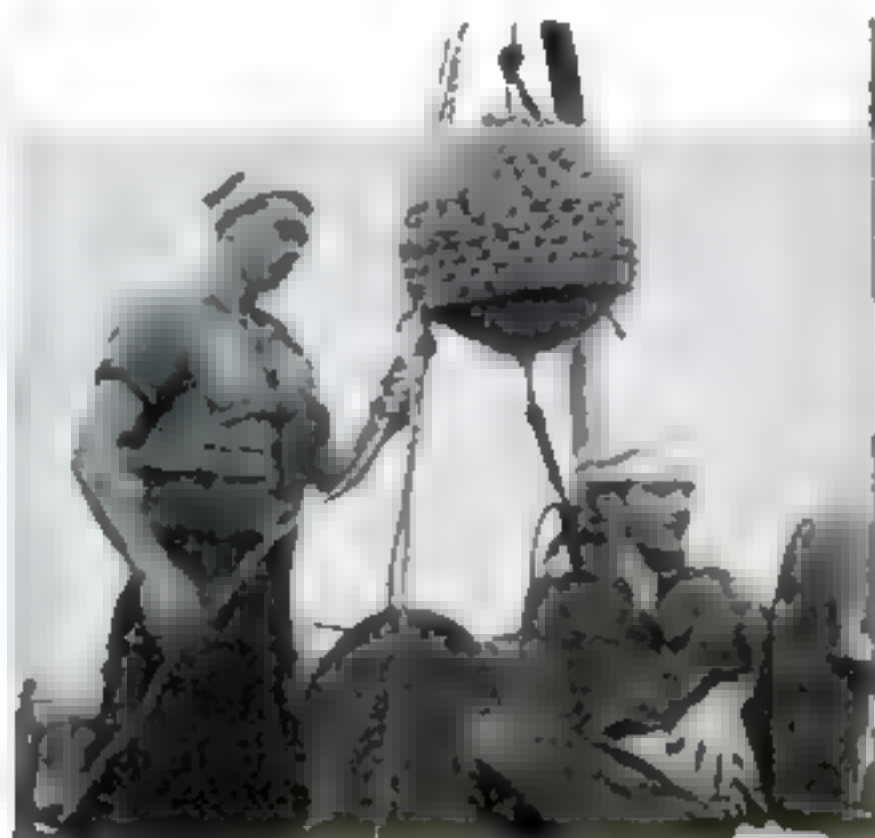
LOOKOUT has not been displaced by new detection devices. The man on watch must be vigilant, scanning the sea continuously through his binoculars



RADIO SHACK keeps the DE in constant contact with the commander of the convoy. When a submarine is scented, every ship gets orders quickly

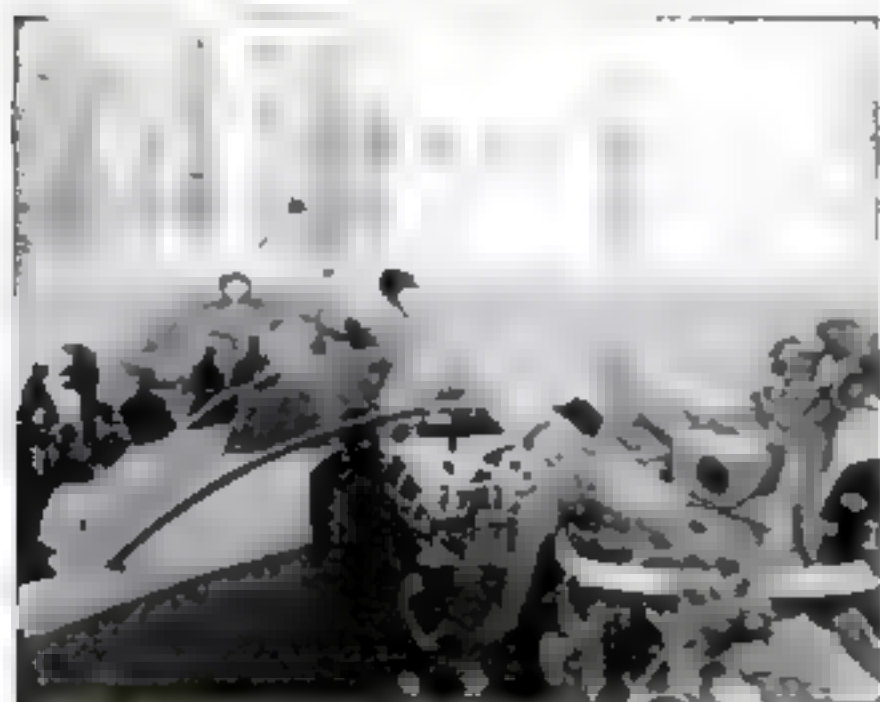


SIGNAL FLAGS supplement radio for communication with other members of the convoy. Here the signalman is seen with the flag locker, ready to break out a fluttering message to a companion ship

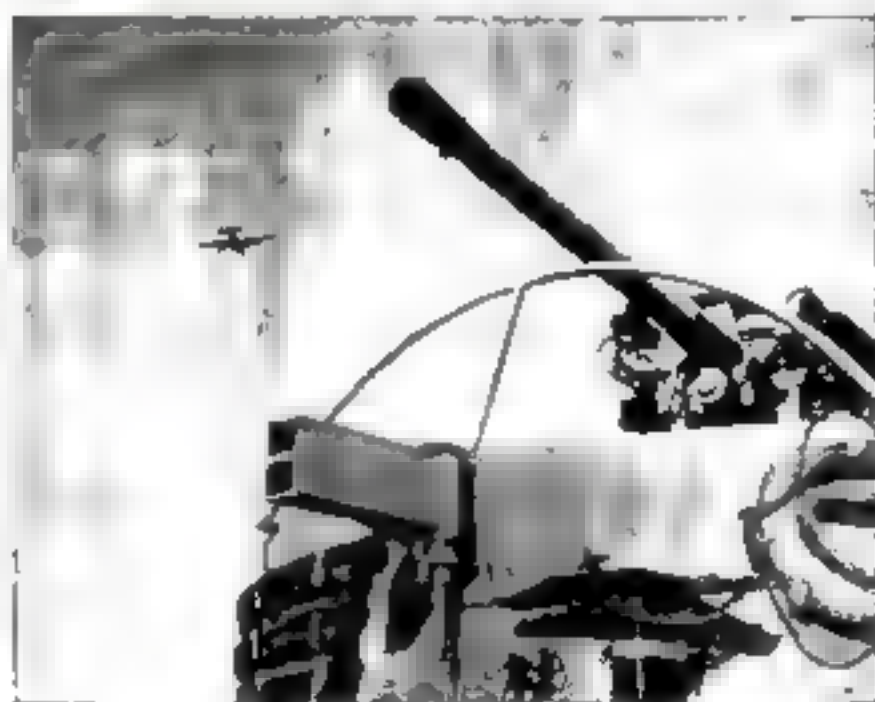


MARLINSPIKE SEAMANSHIP fills in odd hours at sea. This seaman is reinforcing a wicker fender with a series of half hitches. The fender is used as a bumper when the DE comes alongside other ships

THREE-INCHERS would be equally effective in action against a surfaced U-boat and for warding off attack on the convoy by enemy surface craft



FRIENDLY air patrols help protect the convoy throughout its crossing. Here a B-24 Liberator is winging past, keeping a lookout for lurking subs





DEPTH CHARGES lie on sloping racks on the fantail, ready to be dropped astern as the DE races over the spot where a submarine has been detected. "Ashcans" are dropped in patterns designed to make it almost impossible for the U-boat to escape all



LOADING ARBOR. K-guns that hurl depth charges abeam the ship are loaded by means of arbors, which are kept racked along the side of the deckhouse. Here the shank of an arbor is being inserted in the barrel of the K-gun. The curved plate is made to hold the "can"

on the double now. To the three-inch guns at bow and stern, to the 20-mm. anti-aircraft around the bridge and along the sides of the ship, to the Chicago typewriter and the fire-control tower, to the torpedo tubes atop the deckhouse, to the depth-bomb racks on the fantail and the big K-guns which throw the bombs abeam the ship. Hatches battened down; fire crews below decks. Everybody in helmets. A routine general quarters usually is a sleepy and exasperating chore before dawn; but this might be real, and it was tense and eager.

Our ship was making everybody proud of her, showing how maneuverable she was. Her twin screws give her a tight turning circle. She is not so small as you would expect, 306 feet long, with 34-foot beam. She is bigger than the World War four-stackers but much lighter than new destroyers, which carry far heavier armament. Turbo-electric drive gives her flexibility and high speed. Slower than a destroyer, she is much faster than a corvette. She was chasing the echo now at good speed.

Listening to echoes, sighting his bearings, and getting his depth-bomb patterns ready, Bob Denniston was very busy. Depth charges are not dropped singly, but scattered over a wide area to explode at various depths. Patterns are chosen for different purposes.

Most of the techniques of anti-submarine warfare are things we simply don't discuss these days. But it seems safe to assume that the enemy knows

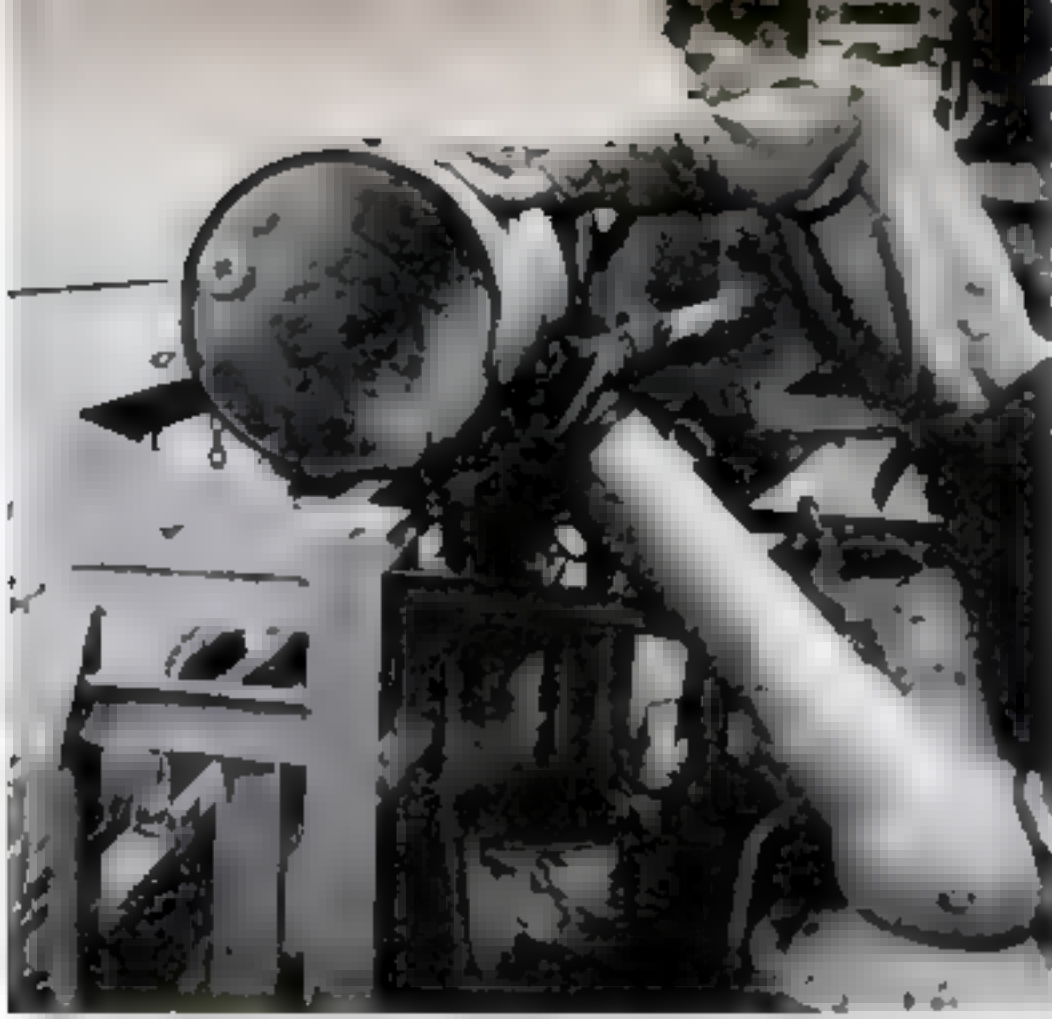
equipment exists which transmits a beam of vibrations through the water and picks up any echoes from it. Direction of the detected object may be determined from the direction of the beam; distance is indicated by the time it takes for the reflected vibration to return.

The vigilance of the escort vessel is continuously symbolized by the steady "poop, poop, poop," of the sound impulses which monotonously rise from the sound hut below the bridge.

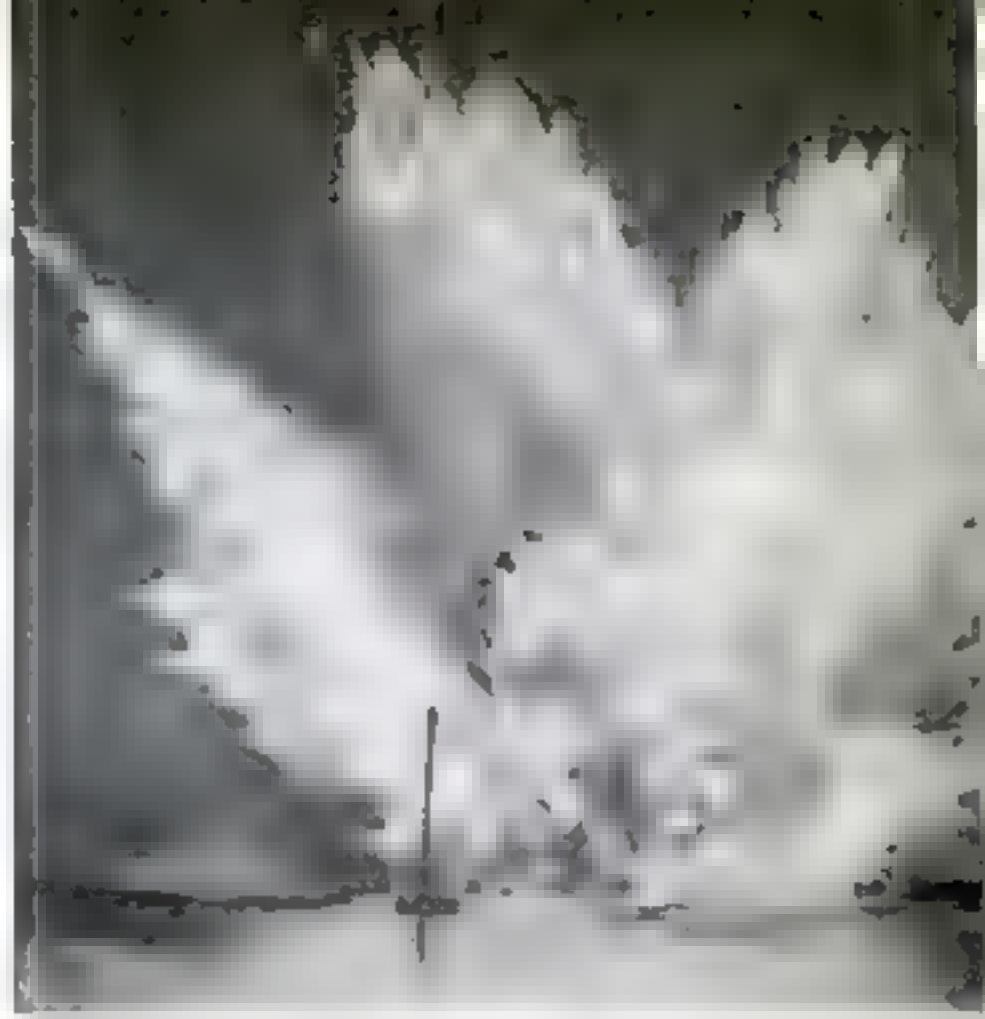
The echoes Denniston was getting over

LAND HO! A welcome sight to every man on board is the first landfall, which heralds the end of the long, dangerous voyage. In easy range for friendly patrol planes, the rest of the trip to port is smooth sailing





ATTACHING THE "CAN." From a rock at the side, the depth charge is rolled on tracks into position on the K-gun and chained to the curved plate on the arbor. When the gun is fired, the arbor and depth charge are thrown into the air together and fall far to side



BOOM! Graceful, flowerlike plumes of spray rising from the water mark the spot where an "ashcan" has exploded, in this official U. S. Navy photograph. The tremendous concussion produced by the blast would crumple the plates of any sub within range

the sound detector were increasingly vague.

We never did get any good echoes from this contact, and soon we were getting none at all. We got the order to resume our place; and the crew secured from battle stations. The convoy had zagged head-on into a heavy sea, and now we were plunging and pitching in a great way, as we speeded up to overtake the fast-moving ships.

She was a good sea boat and not too wet, for her flaring bow threw back the seas and little blue water came over. But there was enough spray to make you know that it was

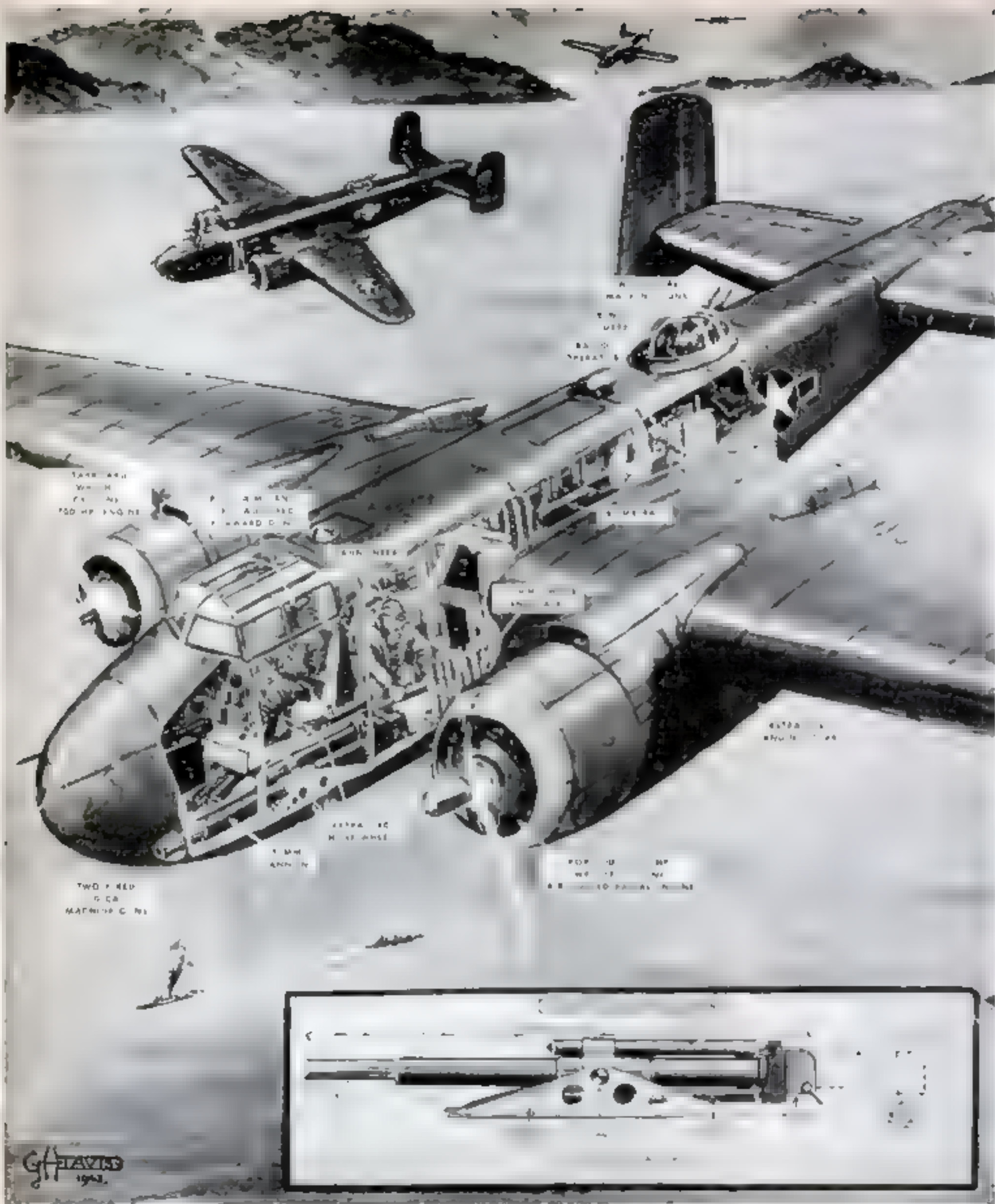
going to be a tough spring on this flying bridge, where the submarine watches are stood. Especially for the skipper, who, except for occasional snatches of food and sleep, sat there continuously in a little perch at the corner.

The skipper, Lt. Robert H. Stevens, watched proudly as his ship bounded along, overtaking the pack. She had not got a U-boat, but if one was there, it had been kept down and the convoy was safe, which was the main thing. Stevens was an Annapolis man *(Continued on page 212)*

LETTERS HOME are censored by the ship's officers as the voyage draws to an end. Details of convoy management and facts about the number and nature of vessels escorted are suppressed for reasons of security

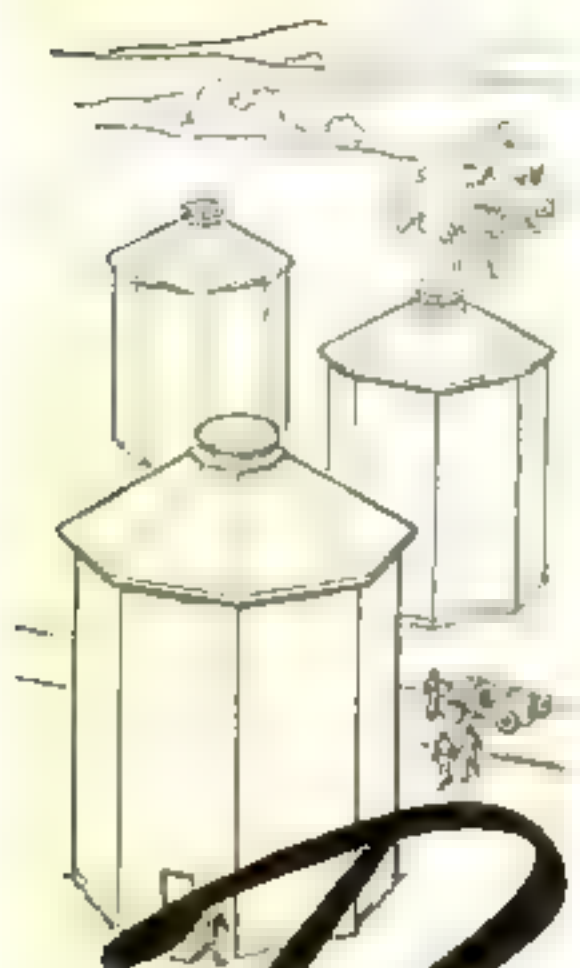
IN PORT at last, the DE finds a berth in a yard of the United Kingdom, where she is hemmed in by destroyers and corvettes. Her men go ashore like old sea dogs for a taste of liberty in a foreign port





Artillery Grows Wings . . . How the world's biggest aerial gun is mounted in the North American Mitchell B-25 medium bomber (P.S.M., Feb. '44, p. 105) is shown in this drawing by G. H. Davis from the Illustrated London News. Mounted beside the pilot, with its muzzle protruding from the lower left of the new metal nose section, the 75-millimeter cannon is loaded by a special crew member. Like the other fixed forward guns, it is aimed and fired by the pilot.

At their stations in the trainer fuselage, bomber crew members are theoretically 10,000 feet above the ground. By simulated stars, terrain, and instrument readings, they carry out their mission



Bombing Tokyo

FROM A SILO

Even a veteran combat pilot gets a thrill out of flying a mission in the Air Forces' magic carpet, the Celestial Navigation Trainer.

By **ROBERT L. SCOTT, Jr.**
Colonel, U. S. Army Air Forces

THE other day, I took off in a four-engine ship, maneuvered to altitude. Crossing the Atlantic Ocean, Africa, the Arabian Sea, India, Burma, and China, I bombed Japan. After I saw my bombs blast Tokyo, I could have flown on over Kamchatka, along the Aleutians to Alaska, then home to Florida. After all this, though, I climbed down the ladder from my ship and

found that I had made a landing in a silo. No, it wasn't a dream. It actually happened—and I'll tell you how.

It began the other day, when I saw, for the first time, several peculiar-looking buildings which rise from Florida's flat, sandy terrain. They look just like the familiar grain silos of our breadbasket country of the Middle West, or the friendly red elevators of Saskatchewan. They are about 40 feet high—cylindrical and with hemispherical domes; you can see the domes

revolving. The whole thing looks like an observatory. Actually, it is the School of Applied Tactics of the Army Air Forces—AAFSAT for short.

The first time I saw these strange-looking houses, I thought we'd gone into the grain business, but when I strolled through the open door of one I found an air-conditioned classroom. The interior was light-sealed and, with the door closed, real darkness pushed in on me. When the lights were turned on, I saw the Celestial Navigation Trainer, a glorified Link Trainer, rising from a heavy concrete base. High above, supported by a tower on a revolving platform, was the fuselage of the "plane."

This fuselage, I found later, was attached to the top of the column by a universal joint, which made possible the pitching and banking of simulated flight. Beneath the airplane was a screen, or terrain plate, which received the projected images representing any part of the earth's surface. I heard that those scenes appeared as if actually viewed from an airplane at 10,000 feet, but others could be projected with any altitude desired. Images of clouds in any given density could be thrown upon the same screen. Drift from anticipated cross winds, or resultants of head winds or tail winds, could also be introduced.

Above the ship, I saw the hemispherical dome, made of chicken wire and holding the lights representing the stars used for navigation. There were also the outlines of the constellations. This dome could be rotated and moved on machined rollers over the dome rail to simulate the passage of time or the change in longitude and latitude. The axis of the sphere, half of which was represented by the dome, fell within the fuselage of the trainer, and thus, by using his bubble sextant, the navigator could determine accurately the altitudes of the collimated "stars."

In a lighted booth, under the ship, was an operator's desk. There I saw various switches and controls by which the attendant moved the dome and terrain plate. He also controlled the radio to introduce problems of actual flying; he could even simulate two radio stations for obtaining bearings within the ship. An automatic recording gadget traced the flight path.

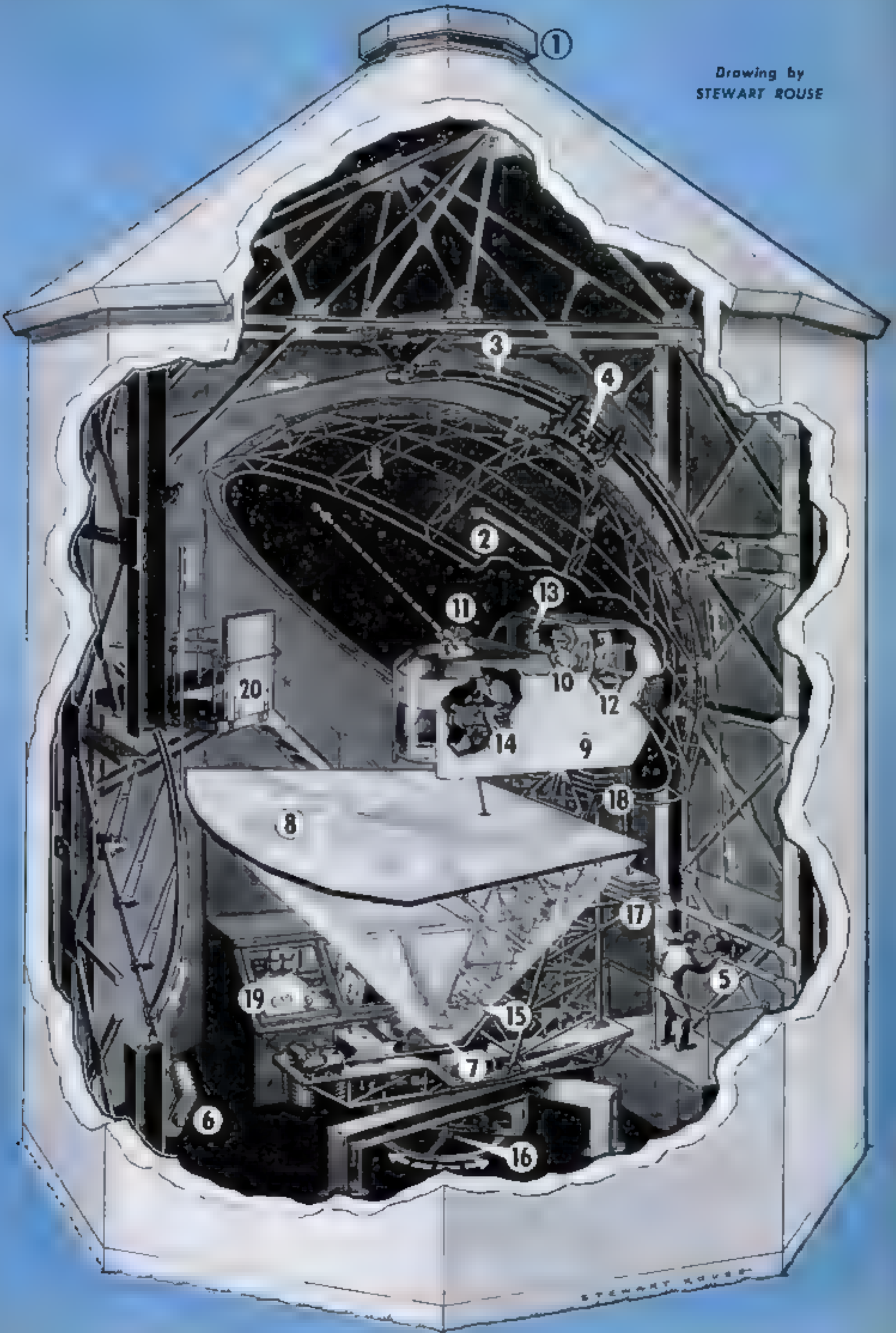
The cockpit of the trainer was that of a four-engine bomber. I entered with my crew—pilot, copilot, navigator, bombardier, and radio operator—and we sat in our usual places for a combat mission. As we started the engines, there came the noise of real engines breaking into life, and I felt the steady vibrations. Every instrument was on the dashboard. Over the radio, the operator called, "All clear for take-off." I checked the fuel gauges and noted that they actually functioned. I heard the operator call for the dome to be set for our flight, and he turned on the time and navigation switches. That set up a motion of the dome, corresponding exactly to the change in the heavens visible to an observer moving at the same speed and in the same direction as the simulated flight of the trainer. A motor began to turn the dome from east to west at a rate equal to the change in longitude. This, of course, depended on the east-west course and the ground speed. At the same time, the latitude drive moved the dome up or down at a rate equal to the change in latitude caused by the north-south course of the ship. Automatically, the dome gear box compensated for the apparent motion, east or west, of the stars.

Taking off in the silo, I had every sensation of flight, and as I looked at the lighted projection in front of the windshield, I saw the trees rushing back toward us—and I almost ducked as they went by, close *(Continued on page 198)*

- 1 Ventilator excludes daylight.
- 2 Lights in dome represent navigating stars.
- 3 Heavy, curved steel rail supports dome.
- 4 Gear box moves axis, motor rotates dome.
- 5 Motor winch and cable move dome along rail.
- 6 Weight counterbalances load of dome.
- 7 Projector throws image of terrain on screen.
- 8 Terrain plate receives projected image.
- 9 Fuselage mounted on universal joint.
- 10 Pilot uses standard instruments, controls.
- 11 Navigator takes bearings from "stars."
- 12 Radio man sends and receives messages.
- 13 Copilot or other crew member.
- 14 Bombardier uses sight, hits are shown.
- 15 Smoke blower produces cloud effects.
- 16 Turntable revolves as pilot uses rudder.
- 17 Bellows tip fuselage for dive or climb.
- 18 Bellows bank fuselage as ailerons are used.
- 19 Operator rules sky, earth, and radio.
- 20 Crew enters fuselage via loading bridge.

INSIDE THE NAVIGATION AND BOMBING TRAINER

Drawing by
STEWART ROUSE





CUSTOM-TAILORING planes to fit different kinds of service is the job of modification plants. Engineers find that it speeds production to make necessary changes at these depots, rather than to disturb regular production lines. This Douglas A-20 Havoc attack bomber is being fitted for long-range missions with a navigator's astral dome in a temporary mount. The regular hatch will be stowed away in the bomb-bay loading platform of the plane for possible later use in reconversion.

FOXHOLE DIGGER. Three tools are combined in the Army's new modified M-1 shovel, seen in the right hand of the soldier in the picture below. Besides doing the work of the old-style intrenching tool, with which it is compared here, it has features which fit it for service as an ax and a pickax. In addition to its versatility, the new shovel boasts a grip of improved design which fits the hand better than that of the old model, with less tendency to produce blisters. The pickax point is a godsend to men caught on clayey or stony ground when the dive bombers and fire from enemy guns start making things too hot for them.



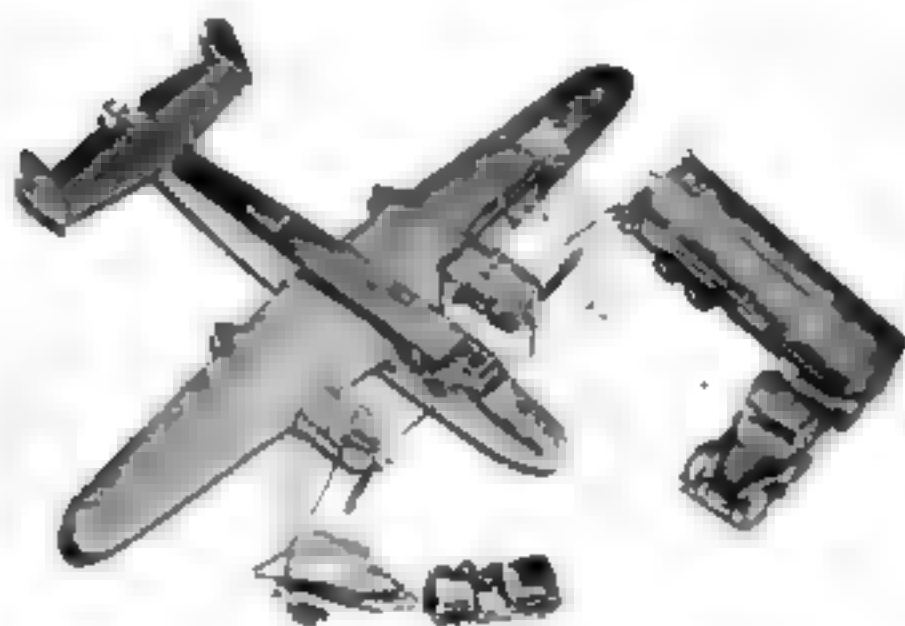
LIFESAVERS for Liberty ships, crash panels held in place by light brads can easily be kicked loose to prevent men from being trapped behind jammed doors during an emergency at sea. The officer is demonstrating an escape.





BATTLE DRESS REHEARSALS are the high point of Army training programs, preparing men for action by putting them through the motions of actual combat until doing the right thing becomes second nature. To

make doubly sure the "enemy" is wiped out, other soldiers will heave live hand grenades into the pillbox being attacked in this U. S. Signal Corps picture of maneuvers at Camp Carson, Colo. Man at left is umpire.



MODELS SAVE TIME and materials at Wright Field, Dayton, Ohio. Engineers use them to help get the "bugs" out of new airplane maintenance and repair equipment before constructing full-size versions. Relationships that are difficult to visualize on the drafting board show up quickly on the carefully built, 1/30-actual-size replicas. A new engine shelter and ladder are being tested on the model B-25 at left. The jeep directly below the nose of the plane is towing a field gas tank, while a trailer truck maneuvers into position on the opposite side.

SUBMARINE SMOKING is theoretically enjoyable with the "peripipe," Hollywood's suggestion for people who aren't happy unless they have a pipe clamped between their teeth. Motion-picture actors in the cast of the musical comedy "Mr. Co-Ed" turned inventors to enable director George Sidney, an inveterate pipe smoker, to get into the swim in comfort. The seagoing briar's 18-inch stem keeps the bowl well out of water even when Sidney—shown rehearsing the swimming star, Esther Williams—has to duck below the surface to do his directing.

APRIL, 1944



My Beat Was the Battlefield



By
**JOHN (TEX)
O'REILLY**

In his 16 months as a war correspondent for the New York Herald Tribune, Tex O'Reilly was in Africa with the Fighting French before the Yanks came. He went ashore in several beach landings, including Salerno. In this story he tells how the newsmen live and work in the battle zones.

THE enemy threat to the Salerno beach-head had been broken. The Fifth Army was beginning to push the Germans slowly back into the mountains. German troops literally had been blasted from Battipaglia by a concentrated bombardment from the air, from the warships offshore, and from land artillery batteries. American troops were advancing cautiously on the town of Eboli.

With three other correspondents, I sat in the shade of a tree beside the white, dusty road leading to the town. We were in a curious predicament. Having passed the most forward American infantry patrol, we were sitting there in that strangely still area between two armies. A captain had told us that an armored patrol would be along soon and that we could follow it into the town. We poked along, but the patrol had not materialized. Finally we had left our jeep and started to walk.

Now we were discussing what to do about it. We were itching to get into Eboli and get the story, but it didn't seem right just to

All a combat correspondent has to worry about is ducking the bullets, "scrounging" food—and getting his stories out.

walk in like we owned the place. After all, possession of the town was something for the opposing armies to decide.

"Let's go down to that next bend in the road, anyway," said Bill Stoneman of the *Chicago Daily News*.

Availing ourselves of the cover provided by a roadside hedge, we walked down to the next bend. There was a fascination about that crumbled town ahead of us. Everything was quiet in that expanse of country between the retreating army and the advancing one. Almost too quiet, we thought at times, with nothing stirring except a couple of horses and an ox grazing in the shell-pitted fields.

After we made several more furtive advances, two American officers came along in a jeep. They had lost their way and were considerably astonished to learn they were in no man's land. We greeted them cheerfully and said, "You



LANDING with an invasion force, a correspondent crosses the beach with his precious typewriter. A pack contains emergency rations, other necessities



AN AMPHIBIOUS RADIO STATION, built onto an Army "duck" truck, went ashore at Salerno to flash the first stories of the landing. The Nazis scented a secret weapon and turned their 88's on it

represent the Army. You go ahead in the jeep and take the town, and we'll walk in behind you. There still might be some snipers in there."

They didn't seem to want the town very much, at least not for their very own. After another lengthy discussion they decided to leave their jeep too, and the six of us walked into Eboli. It was a scene of desertion and devastation. Bombing and artillery shelling had left few buildings untouched. We minced our way through piles of wreckage and around shell holes. The only living things we saw for a time were a pair of oxen gorging themselves on a mountain of grain from a wrecked granary and a dog lying in the doorway of a home that had no rear wall. Finally we met three Italians who had just come back into town and who told us that the last of the Germans had cleared out at 6 a.m.

It was now almost noon, and we started back. On the way, we met the first patrols of American infantrymen coming in. They were a bit startled on seeing us, but we had no time for talk. We had to make a

dash for advance press headquarters with our stories on the fall of Eboli. Soon the four of us, including Stoneman and Mark Watson of the *Baltimore Sun* and Dave Golding of *Stars and Stripes*, were back in our jeep, streaking down the white, dusty road.

This incident is typical of the work of a war correspondent covering the front, except that he seldom finds himself in the sappy position of being out in front of his own lines. The usual procedure is to enter a town with, or just behind, the first troops or armored patrols. This time the four of us forgot that too much curiosity can have the same effect on a war correspondent that it had on the cat.

American war correspondents are paid by the publications they represent but are attached to the Army with the privileges of officers. They wear officers' uniforms, but with the insignia of the correspondent. This varies in different war theaters, although it usually is a shoulder tab with the inscription "U. S. War Correspondent."

In the field they live and eat with the



BILL STONEMAN, of the Chicago Daily News, shared some of Tex's adventures in Italy. He is seen here in the uniform he wore in France in 1939

units they are visiting, or work out of an advanced press headquarters. The latter may be a requisitioned building or in tents if no building is available. At this forward Public Relations office there is an Army mess and jeeps with soldier drivers for transportation in the battle area. This is the initial transmission point for press copy.

There are two things that worry a war correspondent most. One is that he might be on the receiving end of a bullet or shell and the other is transmission of his copy. Army officials are convinced that the latter comes first, judging from the continual sand that correspondents raise about it: the best story in the world is useless unless it can be sent out.

The Allied forces provide facilities for transmitting copy from the front. Press censors travel right with advance Public Relations headquarters to censor copy in the field. A typical example of the channels through which press copy goes before it reaches the home newspapers occurred when this correspondent, along with the others, went into Naples behind the first British armored patrols.

Correspondents wrote their stories sitting in jeeps, with their typewriters on their laps, or perched on a flat stone from a wrecked building. By appointment they met a motorcycle dispatch rider who took their copy to advanced press headquarters. There it was censored, and a record was kept of all arriving copy. Short stories were sent out by a radio unit provided by the Army. These were received at a base headquarters, which relayed them to commercial cableheads which sent them on to America. Longer eyewitness stories were carried by couriers

to an Italian airfield, where a courier plane flew them to the cableheads.

The most trying times, as far as transmission is concerned, come during an invasion. It is then that the war correspondent may be found in his most worrisome mood. He has a great story that he wants to get out, and he becomes harder to live with every hour he has to wait. But transmission technique has been improving with each invasion, and at Salerno a few stories actually were gotten out on the same day that the troops stormed the beaches.

This was accomplished by bringing a complete radio station ashore with the invasion troops. The station was built onto one of the big amphibious trucks called "ducks." An olive-drab house was built over the duck with the station inside. It made a strange sight as it was lowered over the side of a ship and came wallowing toward the shore.

Germans operating their 88's in the hills back of the beach must have thought it was some sort of an American secret weapon, for they started shelling it as soon as it neared the shore. It got so hot that the seagoing radio station had to pull back out of range and wait until some of the 88's had been silenced.

Then it made a dash for the shore and heaved up dripping out of the sea. Switching from propeller to land gear, it rolled ponderously inland. On the way to its destination it ran into a battle where American 105's were fighting it out with German tanks. Pieces of shrapnel went through the housing, but the duck sped to safety. It was set up in a well-camouflaged spot, and that night a number of stories were flashed to the outside world from the thick of the battle.

In an invasion, a correspondent crosses the beach carrying a pack containing emergency rations and a few other necessities. His only other equipment is his typewriter. He is not permitted to carry arms. On his person is a slip of paper indicating that he is a "simulated captain" in the U. S. Army. If he is captured, he is entitled to be treated as a prisoner of war with the rank of captain.

Correspondents in the field sleep in all sorts of places. The writer has camped out in everything from a shallow slit trench in the rocky soil of the western desert to a palatial Italian villa with gilt furniture. In the latter there were no beds, so we just broke out our bedding rolls and slept on the floor amid antique furniture and ceiling-high mirrors.

During the early days of the Salerno invasion, I found that a shallow hole beneath a tree in a fig orchard was a nice resting place. On rising in the morning, you could reach up and pluck a ripe fig for breakfast.

The only drawback was that one night a large, pulpy fig dropped from the tree and landed square in my face. I jumped up with a yell, thinking I had won the Purple Heart while I slept.

Another favorite sleeping place for correspondents during the first week of the Salerno invasion was the yard of a church on top of a hill. From there it was possible to watch the fireworks of modern nocturnal warfare. There were fewer mosquitoes up there, too.

Houses with running water usually are few in the battle-front area. Bathing is done in streams or on beaches—or just isn't done. Once in the western desert with the Eighth Army, I went seven weeks without a real bath and never felt better in my life.

Large newspapers often have two correspondents covering a war theater. One covers at the front, the other at headquarters. After a few weeks they change places. This gives the man who has been at the front a chance to rest up and get better food, and also relieves the other from the mental strain of coping with the turmoil of a big army headquarters.

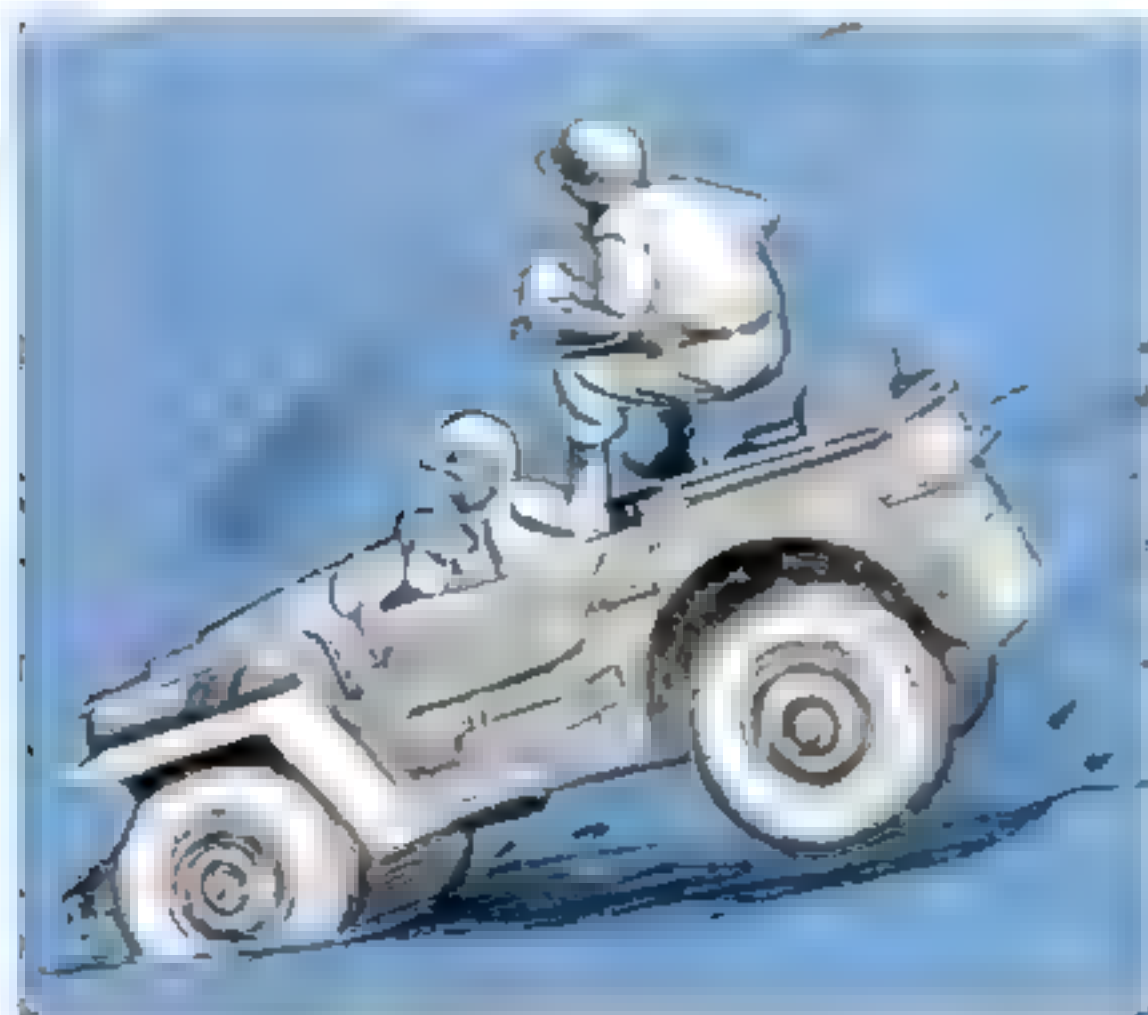
One great activity of the war correspondent is "scrounging," which means going out and trading among the natives for food and drink to augment your Army rations. In the Sahara with the Fighting



"SCROUNGING" food from natives is a major activity of war correspondents. In North Africa, almost any wandering Arab could find a few not-too-strong eggs in his voluminous clothing

French before the occupation of North Africa, I scrounged for camel's milk and ostrich eggs. The eggs were a little strong, but not bad. I guess the milk was all right, but I couldn't help thinking about the factory. In the western desert there were few wandering Arabs who didn't have a hen's egg or two secreted in their voluminous clothing. In Italy it was usually possible to find some old Italian who had worked in America and who, for a few chocolate bars or other articles, would get his wife to fix up a meal of spaghetti with wine and cheese.

Considerable diligence is applied to this scrounging because Army food, although heavy with vitamins, has a tendency to become monotonous. On the morning after the Eighth Army went into Tripoli, I sat with several other correspondents in the main dining room of the Grand Hotel and ate a sumptuous breakfast off a silver table service. The whole menu we had brought with us, because the hotel was practically devoid of food. Fried eggs had been bought from Arabs, soluble coffee had been saved from Army rations. With crackers and baked beans, we were the envy of all there.



JEEPS with soldier drivers provide transportation in battle areas. A reporter may write a story in the quarter-ton — preferably stationary

Proving Ground for

Newly designed airscrews undergo grueling tests at Wright Field, where delicate instruments show how they will withstand strains encountered in actual flying.

Drawings by STEWART ROUSE

HOW will a propeller blade of new design behave when it whirls at full speed through the air? Tiny oblong strips of carbon, attached along its length, help answer the important military question in the great propeller-testing laboratory of the Army Air Forces at Wright Field, Dayton, Ohio. The laboratory has been designed and built by, and is operated under direct charge of, D. Adam Dickey, a civilian electrical engineer, who has been cited for exceptional performance by the Secretary of War.

Spun by electric motors ranging in speed up to 4,900 r.p.m. and in power up to 10,000 horsepower, propellers as large as 16 feet or more in overall diameter give up their secrets. Bending and twisting, the blades impart their strains to the telltale thin carbon strips. And these, in turn, "telephone" their report in the form of fluctuating electric current, just as do the carbon granules in a telephone transmitter. The pulses cor-

respond to changes in the electrical resistance of the carbon, according to the degree of pressure upon it. On the propeller blade, individual wire circuits lead from each carbon strip down along the blade base and hub to a fixed collector known from its shape as a "pineapple."

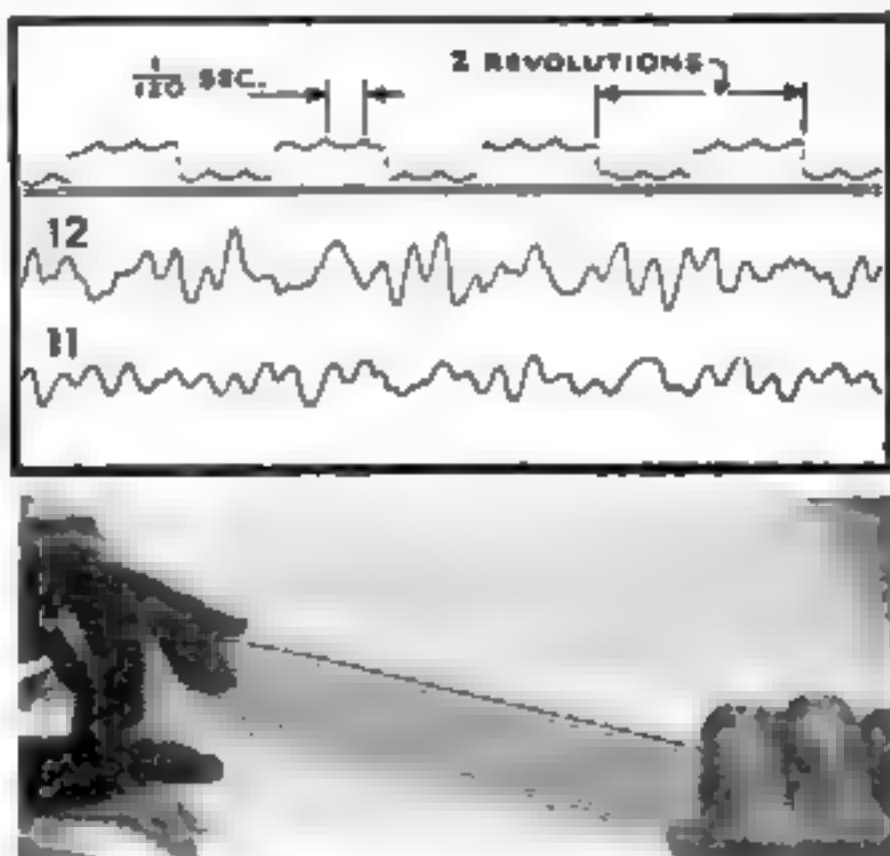
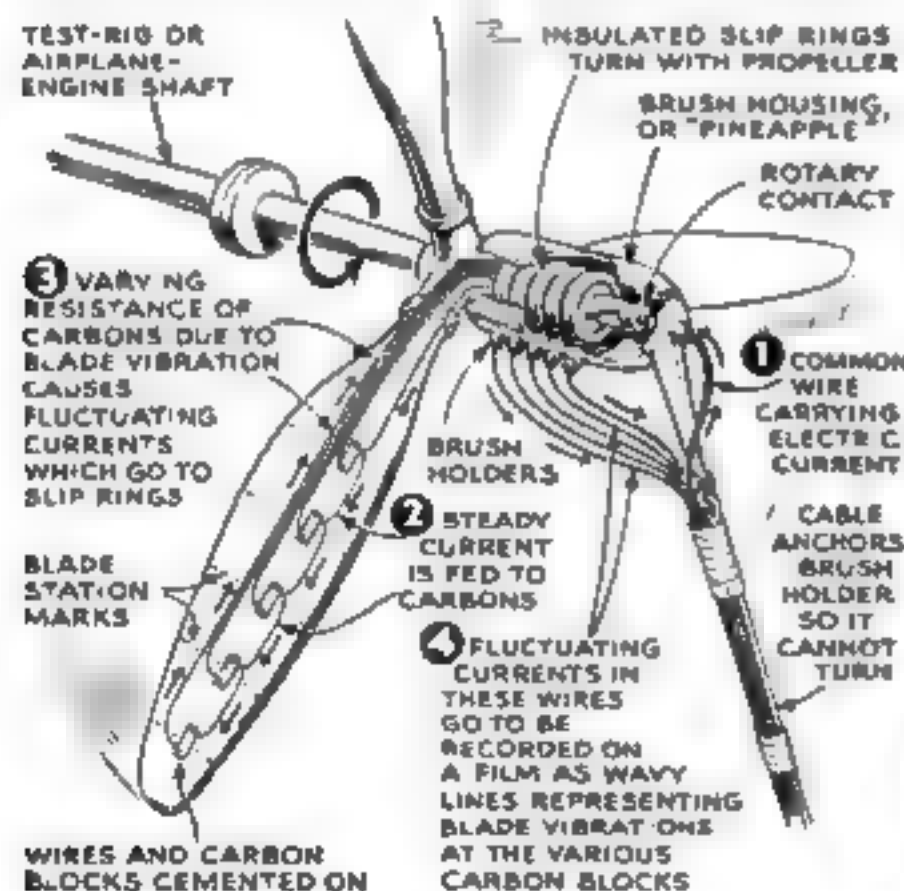
Much as sound traces are imprinted upon motion pictures, current channels from the collector simultaneously trace 12 parallel lines on 35-mm. movie film. Upon development, each vibration record is seen to be an irregular wavy trace. Like the sound trace of a symphony orchestra, it combines many different vibrations. These may come from the blade itself, its mounting, or its gearing, and may include harmonic tones—such as those heard from a musical instrument in addition to its fundamental pitch. If gasoline engines are substituted for electric power, vibrations from cylinder explosions also enter into the record.

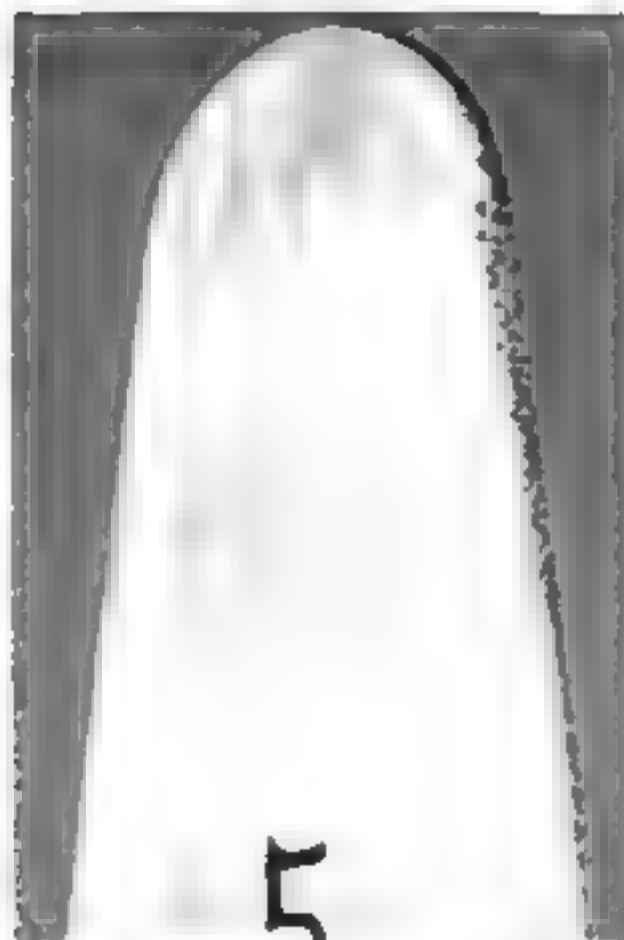
To unscramble this medley, the test film is "played back" in a sound-analyzing room. For audience, it has no human ears. Instead, a photoelectric-cell pickup silently transmits impulses to an electrical analyzer, a marvel of science believed to have no counterpart in the world. Here the complex vibration is broken down into its components. Not only may an observer view the results in glowing lines on the windows of cathode-ray tubes, but a permanent

INGENIOUS DEVICES FERRET OUT VIBRATIONS IN

CARBON BLOCKS, cemented at various points on the blades, are constantly twisted and bent by the blades' vibrations. Resulting changes in the electrical resistance of the blocks are recorded on a 35-mm. movie film, such as is shown at lower right

"UNSCRAMBLED" by the analyzer at right, two of the film's 12 traces are shown recorded on sensitized paper. Top line (13th line on film) is time track. To the practiced eye, wavy lines show where vibrations are occurring in the blade and mounting





HOW WHIRLING BLADES ARE GIVEN THE RAIN TEST

To test the resistance of a propeller's blades to rain, a spray of water is played for 70 minutes on a propeller mounted on a test rig and whirling

at approximately 1,700 r.p.m. The photograph at upper left shows how even the smallest drops of water can chew away the metal at a blade's leading edge

record also is made upon sensitized paper. Thus the vibrations most important to reduce are traced to their source and corrected.

Safe in a tunnel roofed with steel I-beams and heavy timbers, another observer watches

the propeller during the test, using a transit as a periscope to sight through a slit in his protective covering. Many a pilot would be surprised, if not alarmed, to see blades that he thought were rigid become flexible and

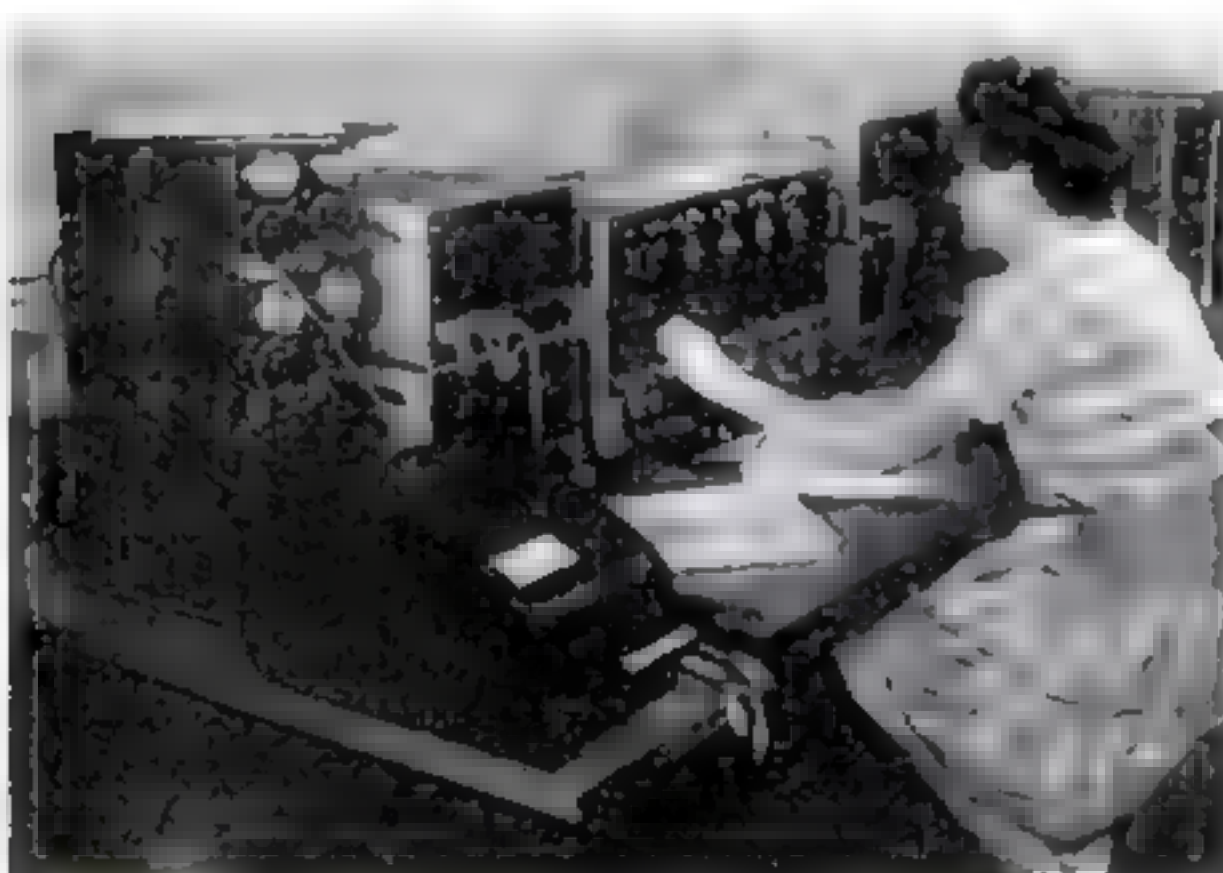
bend from their standstill position. Actually this is perfectly normal. To find just how much a propeller can stand, it may be tested to destruction, by running it at much higher speed and load than will ever be needed in service. Since flying pieces are thrown off in the plane of the circular path of the propeller, the safety walls may be of very moderate width. Once the breaking point is found, engineers assure the pilot a generous margin of safety

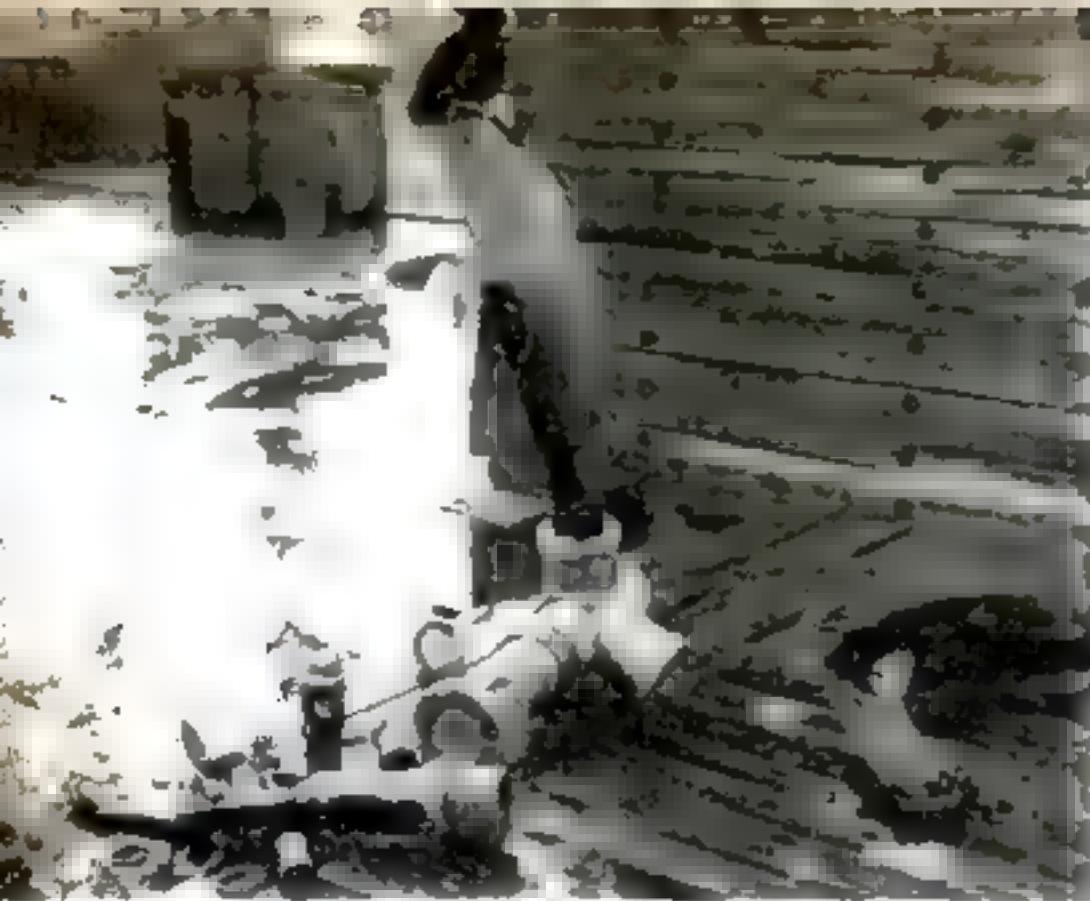
Behavior of a propeller in rain, which nicks its leading edges, and in icing weather, which alters its curvature, shows up in special tests.

How much pull or push a propeller exerts — engineers call it thrust — naturally is a paramount consideration. While electric meters measure the power delivered to the

THE BLADE AND ITS MOUNTING

ELECTRICAL ANALYZER. A photoelectric-cell pickup transmits the film's impulses to the analyzer shown below, where the film's 12 traces, each of which is a composite of many vibrations, are broken down into their components. Results are viewed in windows of cathode-ray tubes, and recorded on sensitized paper (left)



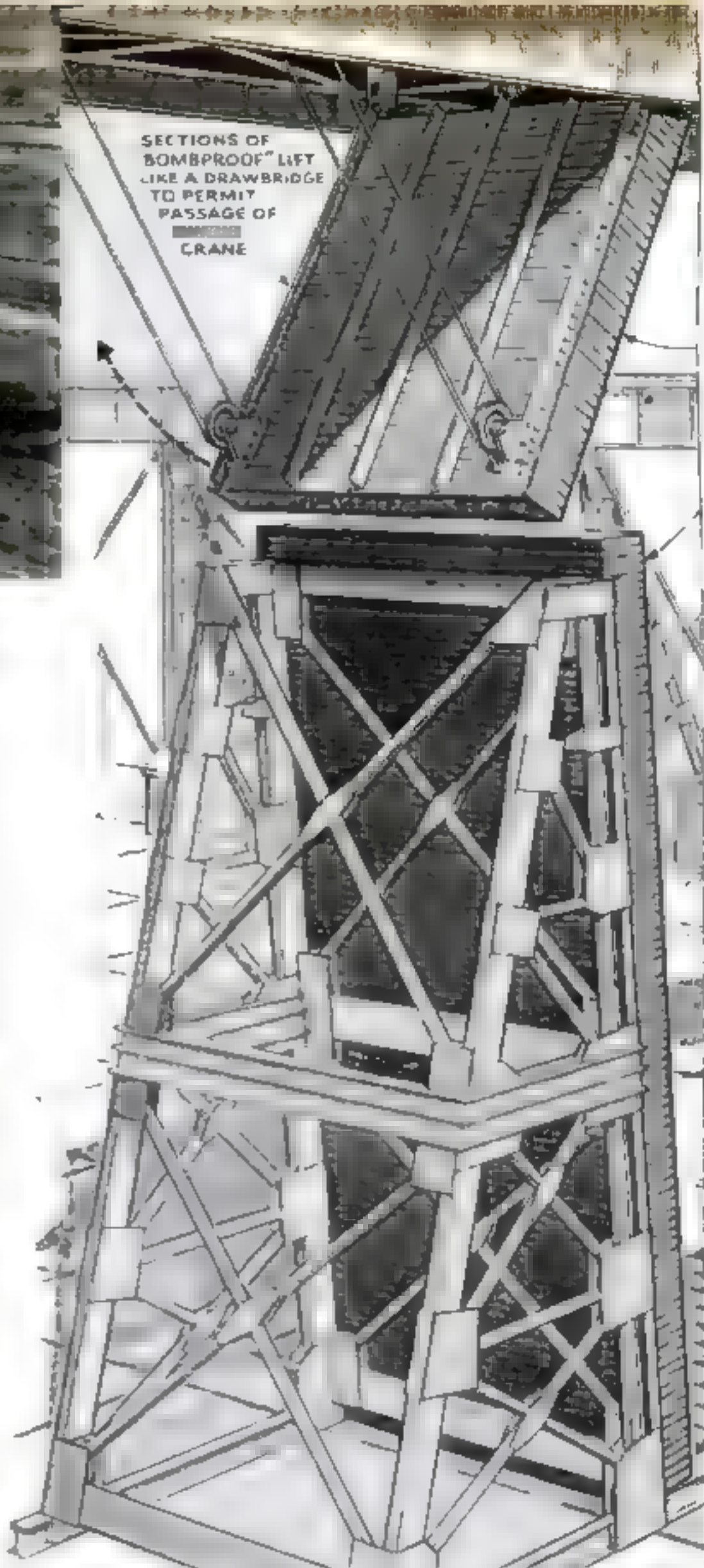


To determine safety margin, "props" are sometimes spun at speeds far above normal. Above, the result when propeller finally "explodes" under the strain

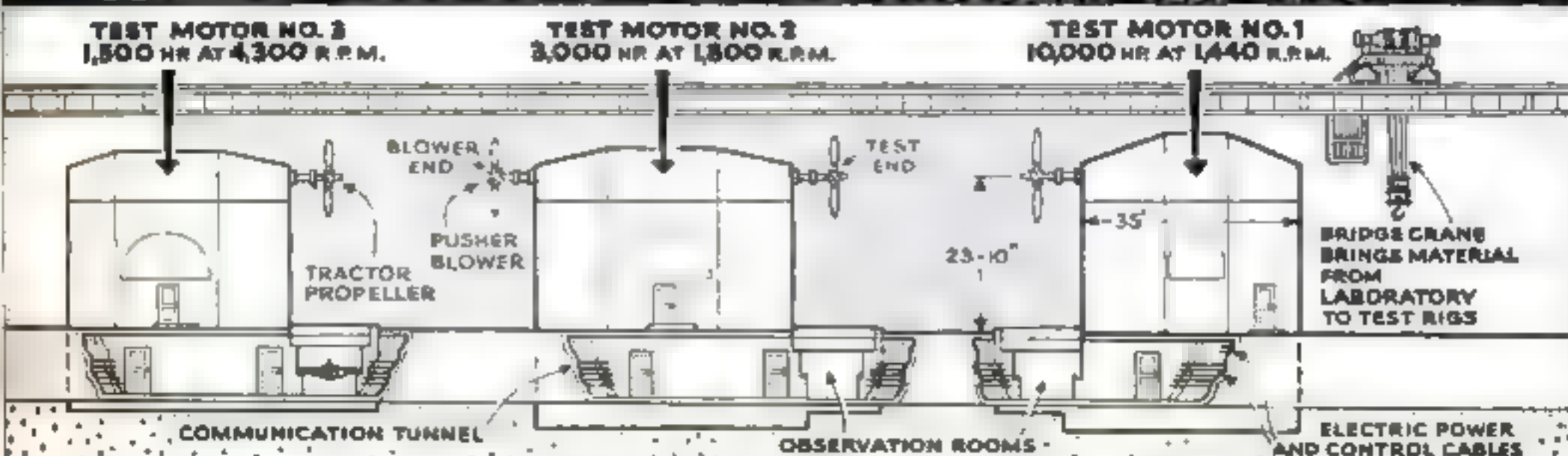
motor, and a counter records revolutions per minute, the propeller shaft bears upon an Emery hydraulic cell through a Kingsbury thrust bearing so that the thrust is ultimately indicated by means of a dial or weighed on a sensitive balance.

The three electric test stands of the installation have been designed for both present and future needs. An airship propeller as large as 40 feet in diameter could be tried out. And, despite the mighty forces at play, precision governs.

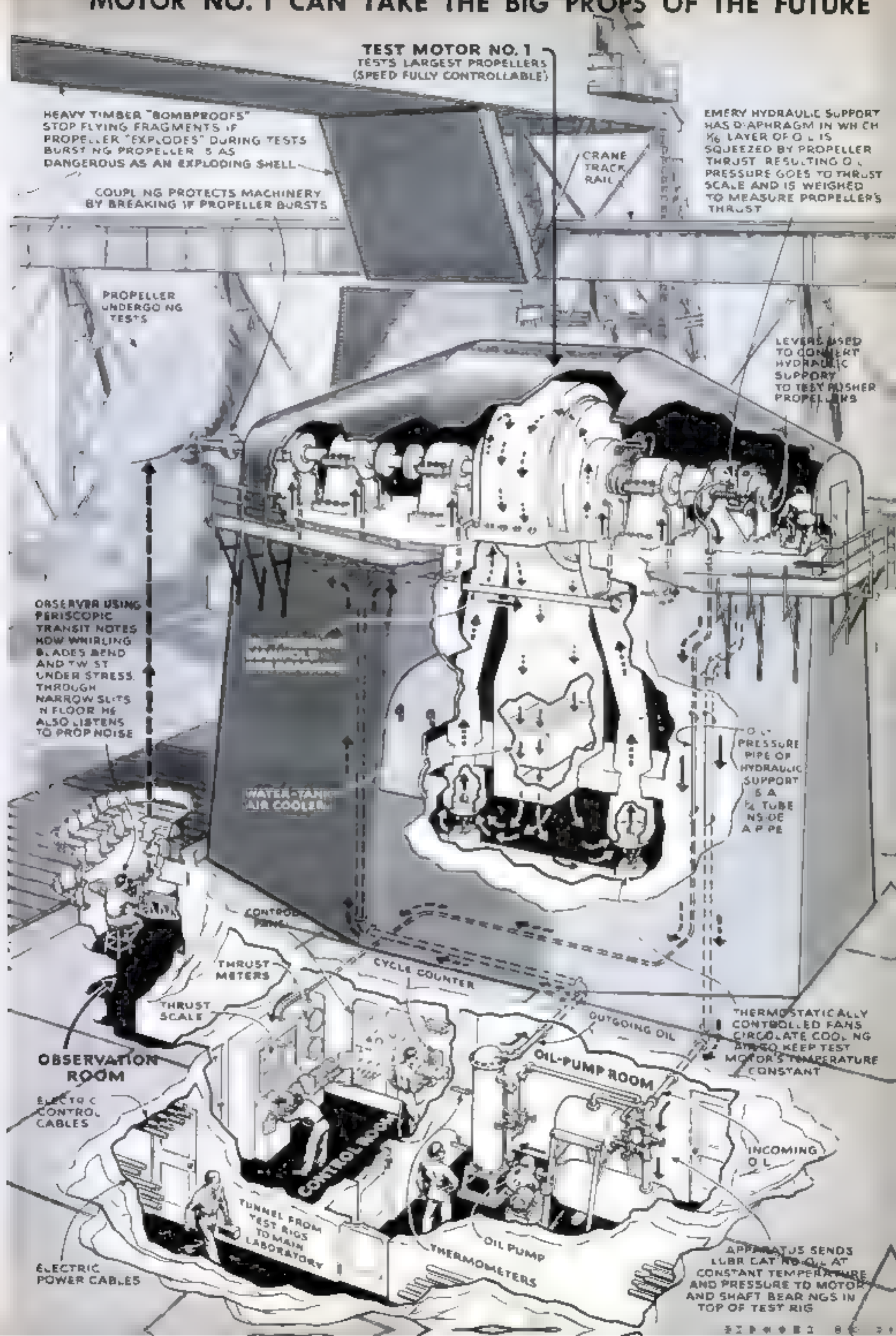
When manufacturers submit competitive models to suit new Government specifications, the interests of the Air Forces and fairness to the makers both demand that the propellers must be tested under precisely the same conditions. Hence an elaborate system of ventilating and lubricating, in each test stand, maintains constant motor and oil temperatures, with unvarying oil pressure in the bearings throughout comparative trials. Allied airmen thus are sure of getting the best that our factories know how to produce.—ALDEN P. ARMAGNAC.



GENERAL ARRANGEMENT OF THE PROPELLER TEST RIGS

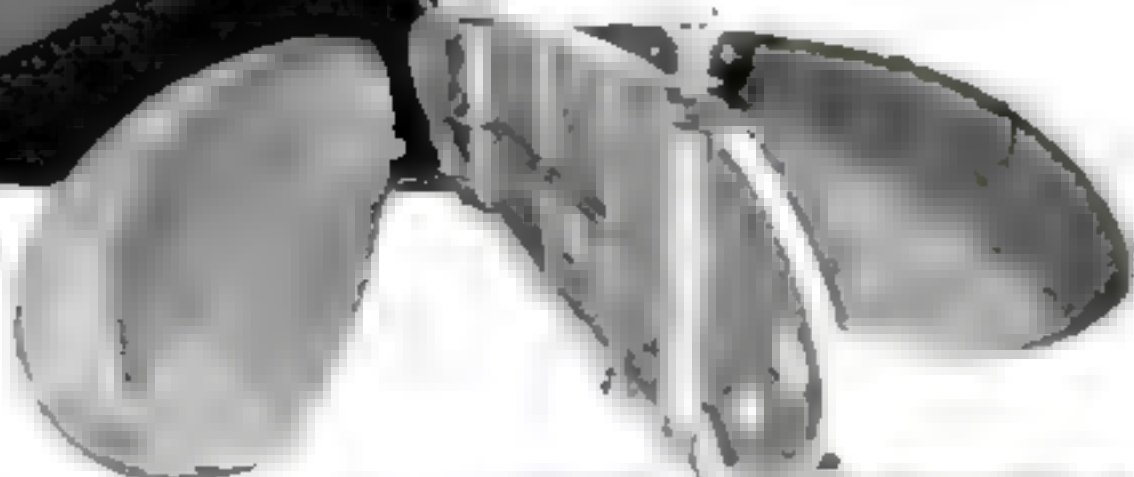


MOTOR NO. 1 CAN TAKE THE BIG PROPS OF THE FUTURE

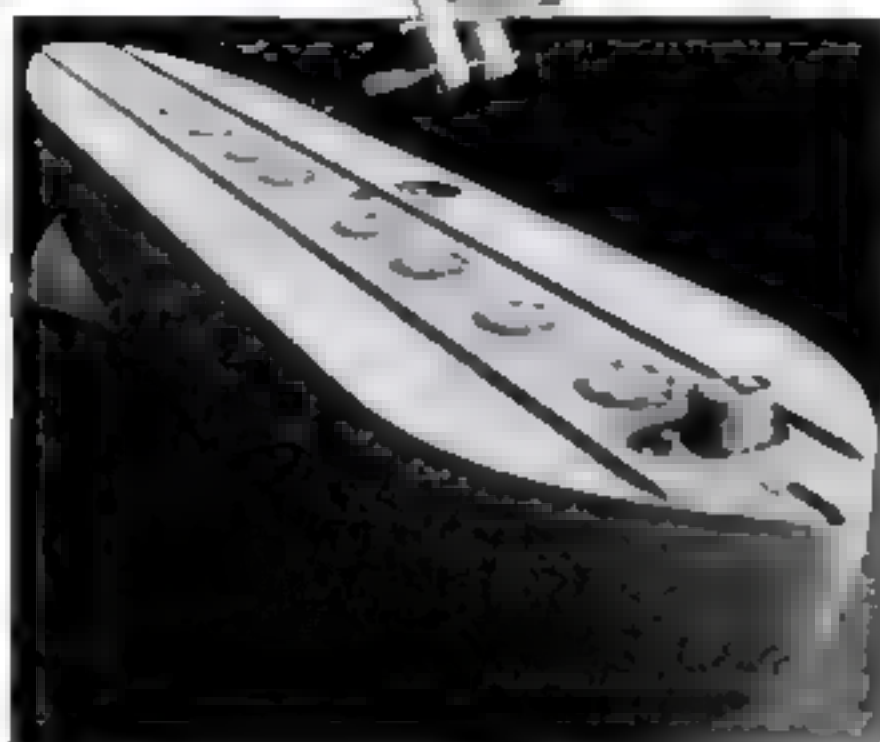




The plywood auxiliary fuel tank at the left is designed for the Navy's F4U Corsair carrier fighter. Below, it is opened to show the half shells and center bulkhead. Lower photo is a huge tank that fastens snugly to the belly of an A-20 attack bomber

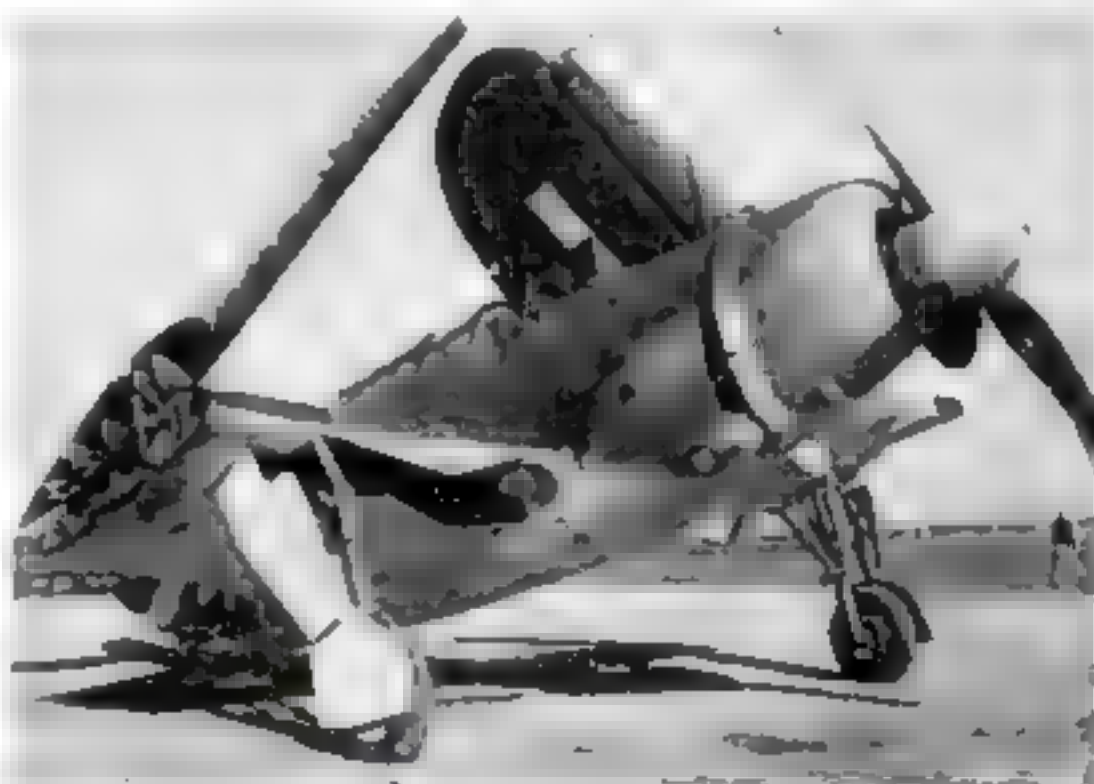


EXPENDABILITY is the keynote of these bonded plywood auxiliary fuel tanks for Uncle Sam's fighting aircraft. Like other droppable tanks, they greatly extend the range of our fighters, enabling planes to reach the point of contact with the enemy with their regular tanks full. When the auxiliary containers are dropped, the ships go into combat without any extra weight or drag to reduce their speed. The tanks illustrated are made by the Duramold process by the Fairchild Engine and Airplane Corporation in New York. Selected plywood is bonded with phenol formaldehyde resins and "cooked" electronically by the radiothermic process (P.S.M., May '43, p. 56), which fuses it into a solid material. It is estimated that the use of these light plywood tanks enables a plane to carry either an extra crew member or his weight equivalent in gasoline and explosives.



FASTER AND FARTHER describes the performance of the Curtiss-Wright Helldivers which are hammering away at the Japs in the South Pacific. Latest of the famed series is the SB2C-1, which owes its success to the incorporation in its design of all the improvements for dive-bombing that have been achieved since the war began. A high-output Wright Cyclone engine powers this low-midwing monoplane, which is equipped with a three-bladed Curtiss electric full-feathering propeller. The Helldiver carries a heavier bomb load with longer range and higher speed than any other plane of its type. Since its first appearance in 1942, there have been more than 880 major design changes that have kept it ahead of all other dive-bomber types. A version used by the Army is designated A-25. The Helldiver takes its name from

the first dive bomber, the Curtiss F8C bi-plane used by the U. S. Navy in evolving this new form of attack between 1927 and 1930. In the photograph below, a Helldiver is shown with its wings folded back as they would be on the deck of a carrier.



PLANE NEWS



LONGEST RANGE and heaviest bomb load of any naval plane in combat service mark the U. S. Navy's Boeing Sea Ranger. The mammoth flying boat owes its phenomenally long range to its wing construction, which employs sheet-metal fabrication to incorpo-

rate six giant integral fuel tanks. Many heavily armed turrets make the plane self-protecting except against unusually heavy odds. Beaching gear that slips key-fashion into the hull enables the craft to be beached easily for repairs.

FORMATION LIGHTS designed by the Grimes Manufacturing Co., Urbana, Ohio, help our bombers to "follow the leader" and keep formation on night missions. Set into a plane's wing near the trailing edge, the flush-type fixture shown below has a prismatic lens that directs the beam to the rear.



"PINWHEEL" TIRES that spin in the slip stream as a plane comes in for a landing mean longer tire life and smoother landings. Rubber-and-fabric fins attached to the side walls open to catch the wind and start the wheel turning, then close in the upper part of the revolution. By getting the wheels up nearly to the landing speed of the plane, this plan eliminates the burning and scuffing that result when tires are jerked from a standstill to high speed in a few seconds. The B. F. Goodrich Company developed the self-starting tires, one of which is seen in the photograph above.

How We Built Our Invasion Fleet

A \$1,000,000,000 armada of thousands of landing craft, ranging from rubber boats to transocean tank carriers, forms the flotillas of victory.

By

ARTHUR GRAHAME



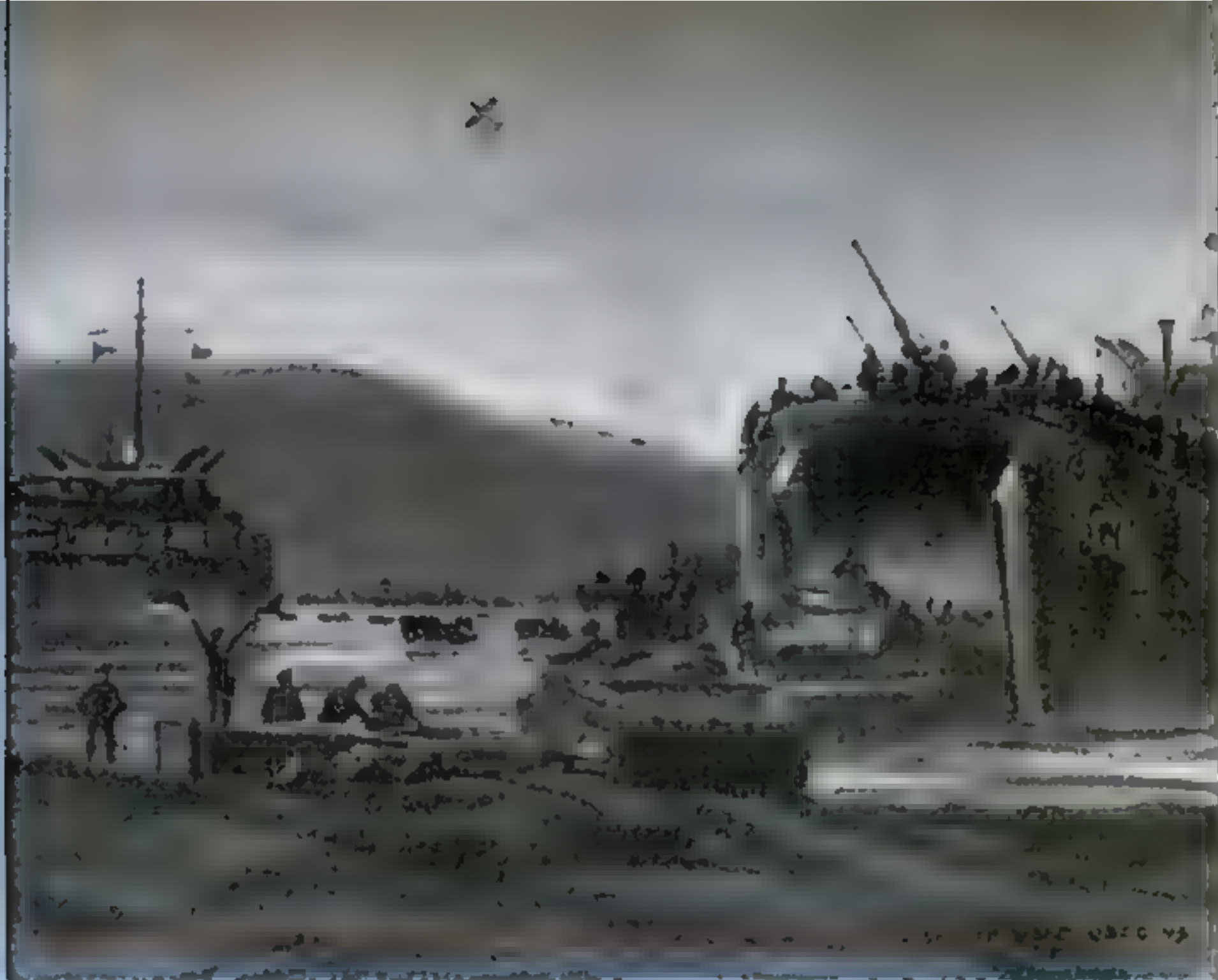
In the cold light of dawn, LST's

THE building for our Navy in less than two years of a billion-dollar armada of over 25,000 landing craft of unprecedented design, ranging from 16-foot rubber boats to 4,000-ton ocean-crossing tank carriers, ranks high among all-time naval construction achievements. During the same period, additional thousands of these highly specialized ships and smaller craft were produced in America for our British allies. Today they are being turned out even faster by shipyards and boat-building and industrial plants in 27 states, and a considerable portion of the five billions recently appropriated by Congress for naval auxiliaries will be spent for them.

These "invasion boats" are our go-getters of victory. They have made possible our successful landings in North Africa, Sicily, and Italy and on numerous Pacific islands. They are a vital factor in the United Nations' military plans for the near future. Used in conjunction with our sea and air power, they provide the means of landing troops and their mechanized equipment

quickly on enemy-defended beaches—the initial and most hazardous operation of the large-scale invasions which will enable our armies to end the war the right way by beating the Nazis and the Japs on their home grounds.

The history of amphibious warfare is as long as the history of specialized landing craft is short. Over three centuries ago, England's Sir Francis Drake was a master of commando fighting. Army and Navy officers now planning seaborne invasion study the capture of Quebec by Wolfe and Saunders in 1759 as a classic example of the proper blending of sea and land power in what then were known as "conjunct expeditions"—what we now call combined operations. But Drake and Wolfe, and the many leaders of amphibious enterprises who came between them, had to be content to ferry their land fighters from ship to shore in their ships' boats, sometimes supplemented by local small craft they were able to capture, commandeer, or hire. Some of their landings were bloody failures because



Drawing by Hunter Wood, U S C G

disgorge cargoes of machines and men on a hostile beach as part of an amphibious operation

quick reinforcement of the troops first ashore was made impossible by the slowness of the boats and by the small numbers of soldiers the boats could carry. If piers weren't available—and they usually weren't—they had to be built under fire before any but the lightest of field guns could be got ashore.

Napoleon was the originator of specialized invasion craft. In 1804, in preparation for the conquest of England, he built hundreds of shallow-draft rowing and sailing boats and barges designed for the sole purpose of carrying his army from Boulogne across 26 miles of salt water and landing it on English beaches. Cornerstone of his plan was the bottling up of the English fleet in the Channel, while the landing was in progress, by the combined French and Spanish fleets holding the Strait of Dover. But the British fleet maintained uninterrupted control of the sea, and Napoleon had to leave his invasion craft to rot on the Boulogne mud flats.

Leaders of amphibious expeditions went on putting their troops ashore in ships'

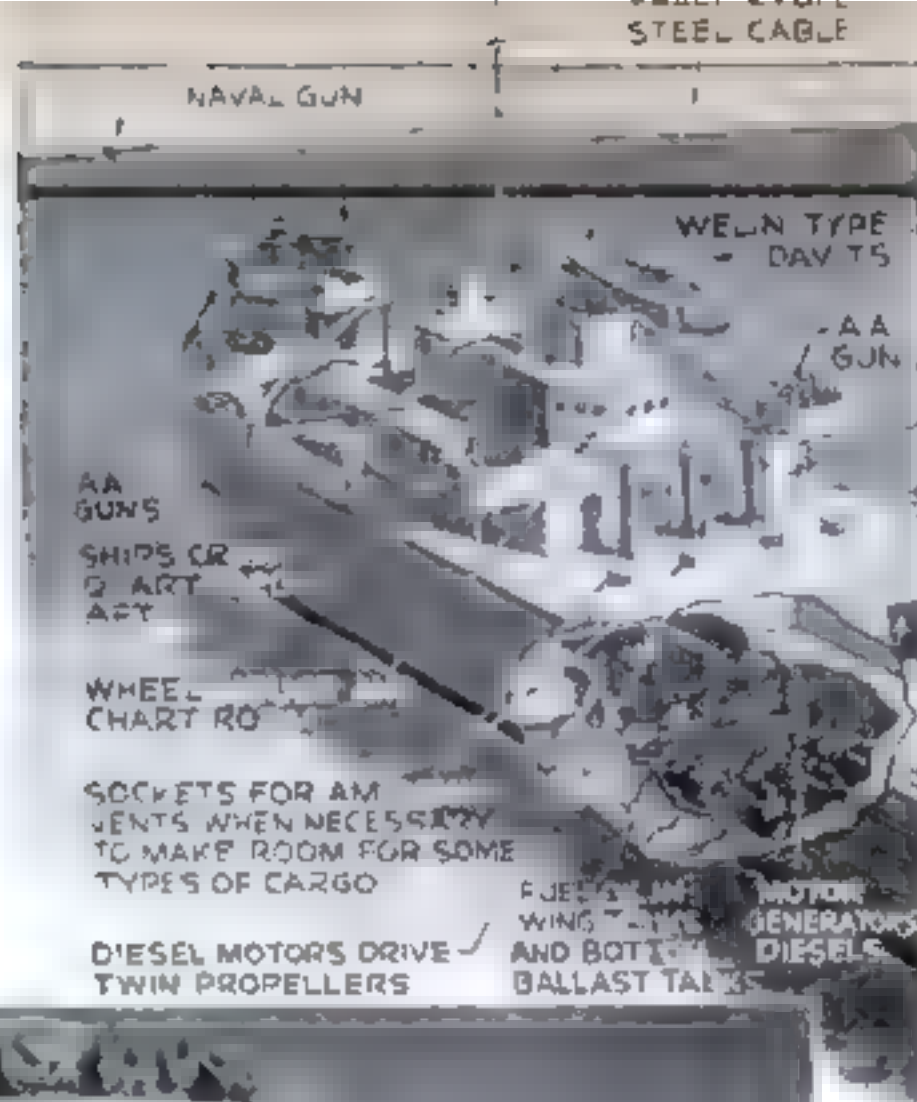
boats. That still was the accepted method of making opposed landings when we invaded Cuba in 1898, although by then the boats usually were towed by steam launches. Lack of suitable landing craft forced us to drop our cavalry and artillery horses overboard with the hope that they would be able to swim to shore, and the loss by drowning of seven percent of these essential animals set European general staffs to thinking about specialized landing boats. By 1913 the Russians were using 40-foot collapsible steel barges capable of transporting either a heavy field gun or 200 soldiers, the British were experimenting with folding wooden boats which carried 50 men, and the Germans were trying out both types.

Early in World War No. 1 the British attempted to capture the Gallipoli Peninsula for the purpose of opening the Dardanelles. In April 1915, British and Anzac troops were landed from transports in ships' boats and a miscellaneous assortment of small craft picked up in Mediterranean ports. The terrible losses in- (Continued on page 76)



Grounded on the beach of a South Pacific island, a landing ship is connected with the shore by means of a mesh road that gives vehicles footing in sand

With ponderous bow doors open and ramp laid down, an LST discharges tanks in Africa. Traffic control gets vehicles out of the hold in orderly fashion



THESE ARE SOME OF THE LANDING CRAFT

LCP(L). Landing Craft, Personnel (Large) This is the original spoon-bow Higgins landing boat. This model is no longer being built, but many are still in use in various theaters of war

LCPR. Landing Craft, Personnel, Ramp. Another early-type troop-landing boat. Like the LCP(L), it is still in service with U.S. amphibious troops, although construction of the model is discontinued



WHEN LST NEARS SHORE
IT DROPS ANCHOR FROM
STERN AND PAYS OUT CABLE

THE LONG CABLE COMES TOWS THE VESSEL
AND TOWS IT OFF - LOSING LOAD INCREASES
BUOYANCY AND AIDS
IN OPERATION

OFFICERS'
QUARTERS, MESS,
AND GALLEY IN
DECK HOUSE

LCT CARRIED AS DECK CARGO
TO INVASION EMBARKATION
POINT - IS SKIDDED OFF THE SIDE

LIFE RAFT

VENTS CARRY OFF EXHAUST GASES
FROM TANK HOLD

BOOBY HATCH

TRAFFIC-CONTROL
BOOTH

QUARTERS
COMBAT

TANK HOLD

AA GUNS

ELEVATOR
DECK CARGO

OUTER DOOR

REMOVABLE STANCHIONS

INNER DOOR
ACTS AS RAMP

RAMP WELL ABOVE WATER LINE
PREVENTS FLOODING IN CASE
OF LEAKS IN FRONT DOOR

OPER

LST, OCEAN-CROSSING TANK CARRIER

NOW BEING USED BY AMERICAN FORCES

LCV. Landing Craft, Vehicle. Capable of carrying a jeep or a light tank along with personnel, this type was evolved by putting a ramp bow on the original Higgins boat, with a broader beam

LCVP. Landing Craft, Vehicle, Personnel. The Navy's standard "beach climber" is 36 feet long, Diesel powered, manned by four men. Can carry a jeep and crew, howitzer and crew, or 36 men



THE WRONG WAY TO BEACH A LANDING BOAT

Coming in from shipside through surf to an unfamiliar beach the operator of this landing boat has made the mistake of thinking he is aground on the beach itself when he really is snagged on a sand bar. Soldiers going over the side find themselves wading into deeper water—under enemy fire.



flicted on the troops by the Turkish machine guns convinced the British General Staff that specialized landing craft were essential for such operations. A result of this costly lesson was the building of shallow-draft barges propelled by gasoline engines, provided with bow ramps which made quick disembarkation possible, and capable of carrying about 500 infantrymen. These "X Lighters," used successfully in the landing at Suvla Bay in August 1915, were the first self-propelled landing craft.

Considerable experimental and development work on landing craft was done between the two world wars. The Japanese used some self-propelled landing barges early in their Chinese operations, and in 1938 used 50-foot troop-carrying barges driven by airplane propellers in their ascent of the shallow Yangtze River. The British designed several types of landing craft, but apparently built only a few experimental models before the outbreak of the present war. The Germans produced quantities of rubber boats and rafts, which proved highly effective in river crossings; how far they progressed with craft designed to land troops and their mechanized equipment on ocean beaches is not known.

When, in 1935, our Navy became interested in troop-landing barges to be carried in the boat davits of transports, a New Orleans builder of motor work boats had developed

a craft which, in its essentials, was just what was needed. Andrew Jackson Higgins had been building—and improving—his "Eureka" boats for 20 years. Originally designed to meet the needs of the fur trappers of the southern Louisiana bayous, they were being used in large numbers by Louisiana oil drillers and by Central American oil and plantation companies. They could operate in very shallow water, carry heavy loads, and withstand almost unlimited hard usage. Their spoon bows enabled them to slide over sand bars and drift logs and land almost anywhere. And they were fast; a number of years ago a Higgins boat established the still-standing record of 72 hours for the 1,150-mile Mississippi River run from New Orleans to St. Louis.

After a lengthy period of development, minor design alterations, and testing, the Navy adopted a 26-foot-long, 10½-foot beam, Diesel-engine-powered modification of the Higgins "Eureka" model and gave it the type designation LCP(L)—*Landing Craft, Personnel (Large)*. These original-model Higgins boats have been used extensively in the Pacific, and by British Commando raiders.

Somewhat later a 36-foot ramp troop-landing boat produced by another builder also was adopted, and designated LCPR—*Landing Craft, Personnel, Ramp*.

Shortly after Pearl Harbor, offensive

LANDING CRAFT (Continued)

LCR(L). Landing Craft, Rubber, Large. Used chiefly by Marines. Sixteen feet long, four feet wide, it carries 10 men.

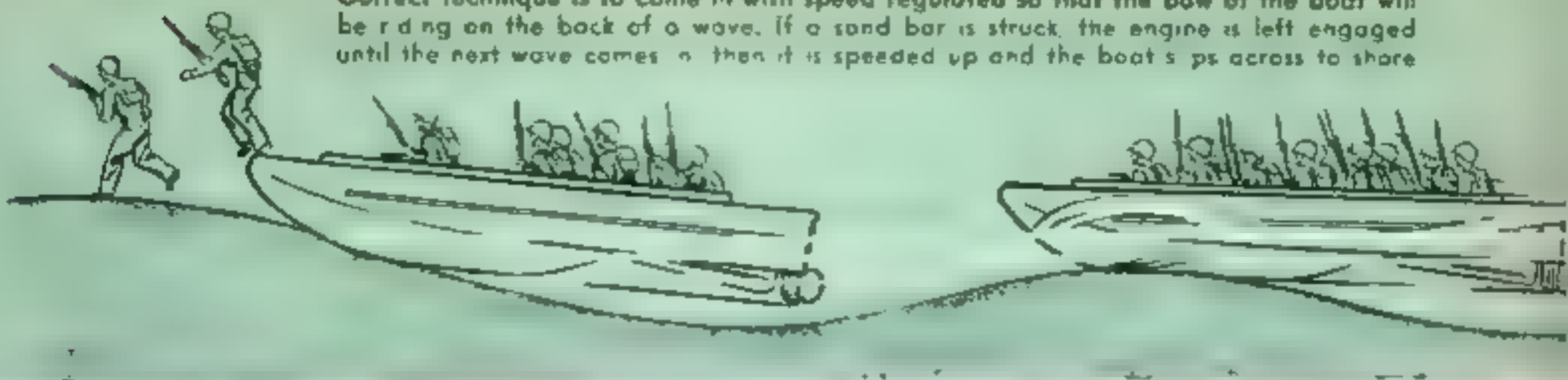


LVT. Landing Vehicle, Tracked. A tracked fighting and personnel-carrying amphibian. The type illustrated below is the "Water Buffalo" (LVT-2), an improvement on the "Alligator" shown on page 79. LVT's crawled up the beach at Tarawa and helped clean up the Japs.



THIS IS HOW IT SHOULD HAVE BEEN DONE

Correct technique is to come in with speed regulated so that the bow of the boat will be riding on the back of a wave. If a sand bar is struck, the engine is left engaged until the next wave comes on, then it is speeded up and the boat slips across to shore.



operations being planned for the Pacific theater made necessary the prompt production of a landing craft capable of carrying a jeep or even a light tank, and of landing its load quickly. Higgins solved this design problem by giving his original boat a ramp bow and a few additional inches of beam. This type was designated LCV—*Landing Craft, Vehicle*.

Today's LCVP—*Landing Craft, Vehicle, Personnel*—was developed from the earlier Higgins boats. It is the Navy's standard "beach climber," and with the exception of a rubber boat the only one now being built. It is 36 feet long, has a beam of almost 11 feet, is armed with two .30 caliber machine guns, and—like all our landing craft—is Diesel powered. Operated by a four-man Navy crew of coxswain, engineer, signalman, and bow-hookman who operates the ramp and doubles as a gunner, it can carry either 36 fully-equipped infantrymen, a light howitzer and its crew, or a jeep and its crew. Built of plywood, with a triple bottom, its construction and design are protected by a score of patents.

The Navy placed its first quantity order for Higgins landing boats in November 1940. Some months ago Higgins Industries celebrated the launching of its seven thousandth "beach climber." LCVP's also are being produced under Higgins patents—given to the Navy for the duration—by several other

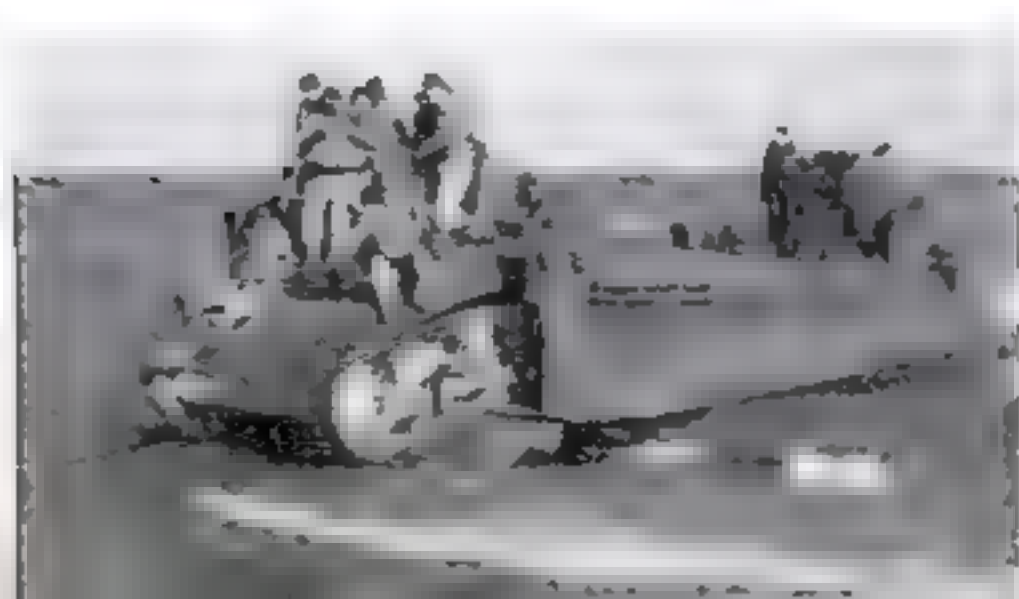
builders in various parts of the country.

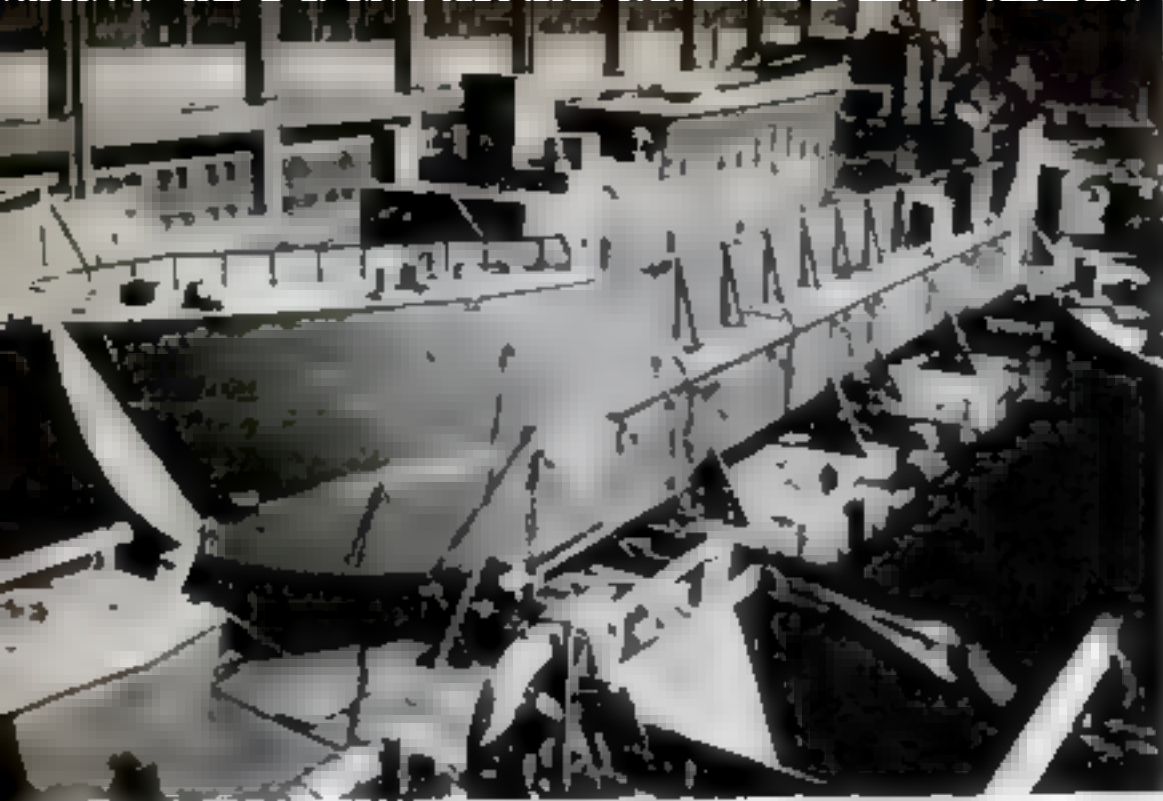
Inflated rubber boats sometimes are used by the Marines, especially when they "shove off" on landing missions from small auxiliary vessels. LCR(L)—*Landing Craft, Rubber (Large)*—is the standard type. Made of heavy rubberized fabric, it weighs about 450 pounds, is 16 feet long and about four feet wide, and carries 10 men. Most of the boats of this type are propelled by paddles, but some of them have extension-shaft outboard motors hung from wooden brackets strapped to their sterns.

In 1936 the Navy started the development of tank-landing lighters for the Marine Corps. After several years of experimentation the Higgins-designed 45-foot LCM-2—*Landing Craft, Mechanized, Model 2*—was accepted. The first craft of this type was built in the street back of the Higgins plant early in 1941, and still is in service in the Pacific. When it became evident that medium tanks were going to be vitally important weapons in this war, the LCM-2 type was enlarged into the now standard LCM-3, which is 50 feet long and 14 feet wide. Built of steel and powered by two Diesel engines, it carries a medium tank or a heavy gun or truck, and is so fast and easily handled that it can be used with the "beach climbers" in the first assault wave. Higgins has produced well over 1,000 LCM's, and they also are being built under the

LCM. Landing Craft, Mechanized. The standard 50-foot ramp-bowed craft used in landing light or medium tanks for the first assault wave on a beachhead. Built of steel, it is powered by two Diesel engines. Can carry a bulldozer, light gun, or truck

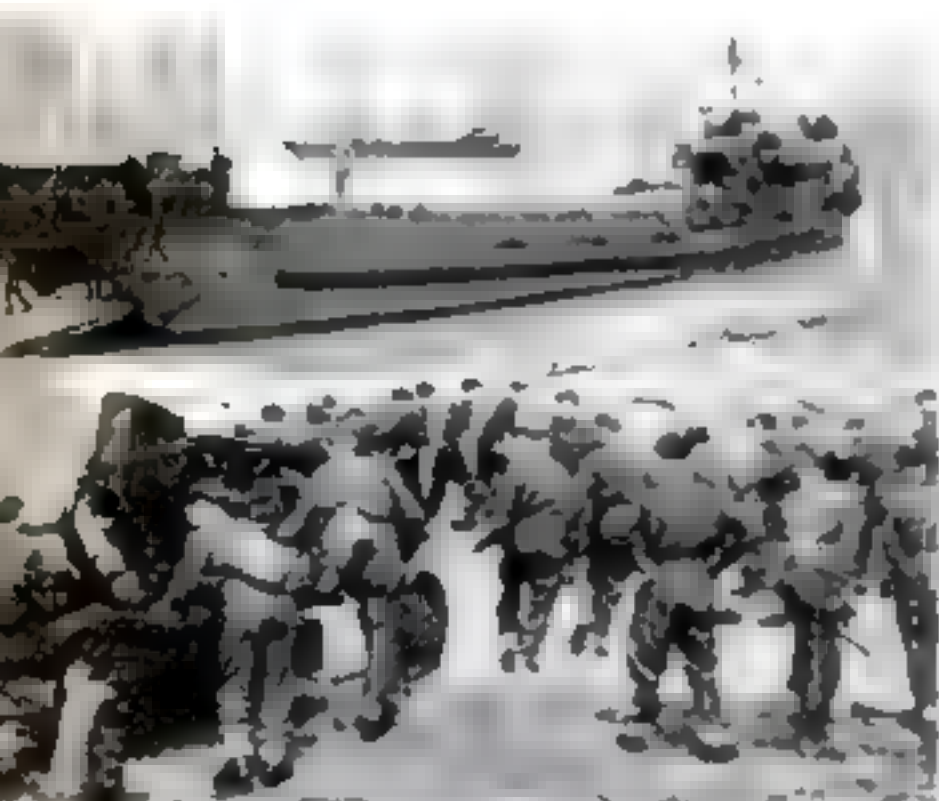
LCS. Landing Craft, Support. This "sea-going bazooka" is armed to the teeth with rocket-shell projectors and machine guns. Armored, it leads other boats to the beach and is equipped for laying smoke screens





NESTING saves space in transporting landing craft. Here an LCT is lashed to the deck of an LST. Inside it is an LCM, while an LCVP tops off the load. The seagoing LST will carry the three other craft to the point of embarkation for attack

BRITISH invasion vessels have developed rapidly since Dunkirk. Below, troops are preparing to load a Bofors antiaircraft cannon on a tank landing craft during invasion maneuvers



JAPANESE troops have used self-propelled barges since their early operations in China. The specimen below, captured in the South Pacific, is driven by a kerosene engine. With a double steel hull, it holds 150 men



LANDING CRAFT (Continued)

LCT. Landing Craft, Tank. Medium-sized lighters used to land medium and heavy tanks and guns. Built in three sections, they ride as deck load on ships



LCI. Landing Craft, Infantry. Over 150 feet long, these heavily armed ships can be beached to land about 200 infantrymen by means of ramps. Like the LST's, they are able to go across the ocean under their own power. They played a part in the Sicily and Kiska landings



Shortly after the Dunkirk evacuation in 1940, the British, determined some day to get their army back on the Continent, began to build landing craft. They developed several satisfactory types of medium-sized tank-landing lighters, but experience in mechanized warfare convinced them that for large-scale invasion operations they also would need tank carriers of an entirely new type—powerful and seaworthy ships which could transport large numbers of medium or heavy tanks on long ocean voyages, but which could also be beached so that their tanks could be landed quickly under their own power. The original conception of this unheard-of sort of ship is said to have been a product of the fertile mind of Winston Churchill.

When our Lend-Lease law was enacted in 1941, we were asked to undertake the building of all the larger types of landing craft. British Navy officers came to Washington in November and conferred with officers of our Navy's Bureau of Ships. The result of their talks was the LST—*Landing Ship, Tank*. Twenty months after the design was sketched, ships of this type had disgorged their tanks on the beaches of Sicily, Italy, and various Pacific islands.

LST's are husky steel ships well over 300 feet long. Most noticeable of their many novel features are the ponderous bow doors which are swung open when the ships are beached to discharge their tanks. The large open space in the hull resulting from the two-deck-high tank deck, which runs far aft and is kept free from fumes by ventilators opening on the upper deck, posed a difficult structural-design problem which was solved by extensive compartmentation of the lower hull. Except that LST's draw more water aft than they do forward, nothing may be said about the underwater hull design that makes them both seaworthy and capable of being beached. *(Continued on page 200)*



M-4 TANK is one of the fighting vehicles that ride to battle on LST's and other landing craft. This one is practicing invasion tactics in England



"ALLIGATOR," This amphibious tank (LVT-1) swims ashore, propelled by fins on its treads. An improvement on it is the "Water Buffalo" (LVT-2)



THE "DUCK" is an amphibious truck used for carrying men, weapons, supplies, and ammunition to shore. Six wheels enable it to crawl over any reefs

LSD. Landing Ship, Dock. Designed for docking operations, this vessel is about 450 feet long. Further details of its construction and use are not revealed

LST. Landing Ship, Tank. Husky steel ships over 300 feet long. Manned by crews of eight officers and 85 enlisted men, they carry tanks, trucks, and cargo



Shown below is a corvette of the 'Flower' class, of which Britain now has about 100 in service. These escort vessels average about 1,000 tons and carry a complement of around 75 officers and men. Armament consists of a rapid-firing four-inch gun, two 20 mm anti-aircraft guns, and a Bofors gun. Each vessel also carries four depth-charge throwers and two sets of dischargers for dropping the charges over the stern. To date, these corvettes have sunk over 25 U-boats and seriously damaged at least 20 more.



- (1) Depth charge dischargers
- (2) Smoke floats (3) No. 1 anti-aircraft gun
- (4) Engine room
- (5) Petty officer's cabin
- (6) Depth charge throwers
- (7) Corvey float (8) Engine room
- (9) Depth charges (stowed)
- (10) Vents (11) Bofors gun
- (12) Shelter (13) Corvey float

- (14) After battery
- (15) Side battery
- (16) Forward battery
- (17) Electricians' store
- (18) Officers' double cabin
- (19) Dinghy (20) Waterway tunnel
- (21) Crew's mess
- (22) Port 20 mm gun (23) Bridge
- (24) Navigator's window

- (25) Deck on landing platform
- (26) Wheelhouse and wireless cabin
- (27) Stairs to lower hold
- (28) Berthing
- (29) Storage
- (30) Staircase
- (31) Lamp room
- (32) Dispensary
- (33) Officer's single cabin
- (34) Officer's single cabin
- (35) Officer's single cabin

- (36) On-line bunker
- (37) Fresh water tanks
- (38) Crew's accommodations
- (39) Crew's mess deck
- (40) Quick-firing four-inch gun
- (41) Windlass
- (42) Crew's accommodations
- (43) Gun mount tower
- (44) Crew's accommodations
- (45) Fresh water tank

Drawing by G. H. Davis from The Illustrated London News



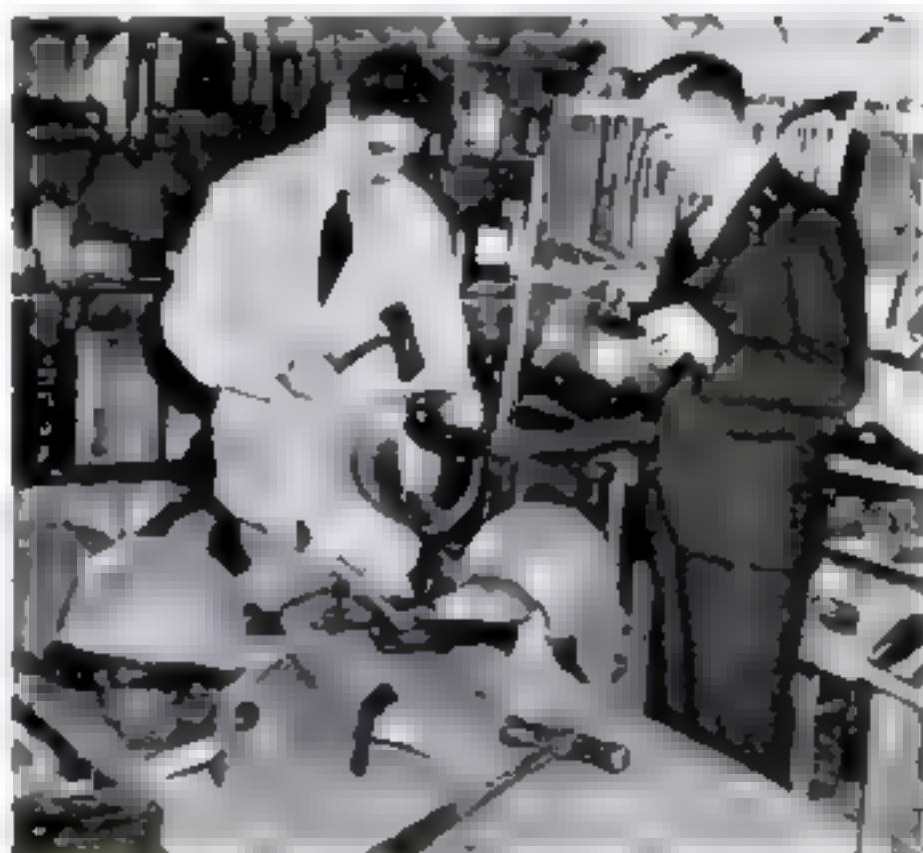
A fifteenth-century Italian helmet is seen at left with a modern aviator's cloth skullcap to display ancient influence on present design. Earphone holes are covered by flaps when helmet is adjusted to the head

Working with an ancient drawing hammer on a rough mass of soft Swedish iron, the armorer begins the initial operation, the tedious task of shaping the metal on a wooden block

Medieval Tools Shape Air Armor

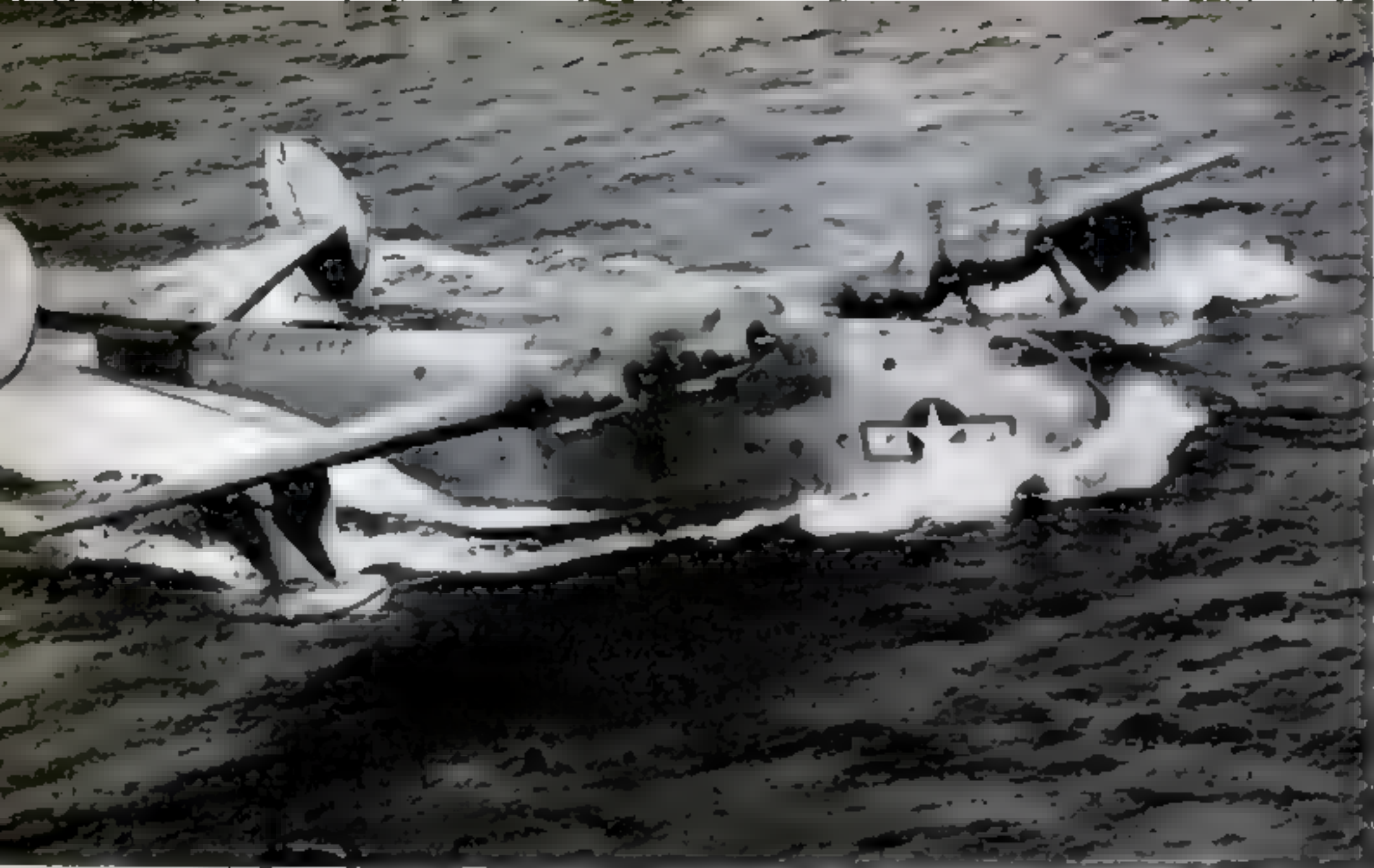
ARMOR that was worn by Italian nobles before Columbus discovered America, and the tools with which it was fashioned, are being used today in the design of aviators' armor. In New York's Metropolitan Museum of Art, which houses 10,000 items of arms and armor besides the world's largest collection of armorers' tools, Steven Grancsay, curator of this branch, heads a secret workshop where models for both head and body armor are made for the Army Ordnance Department.

The work, consisting entirely of experimentation aimed at the improvement of body armor and helmets worn by fighting airmen, is conducted by Mr. Grancsay and his two assistants behind a steel door marked "No Admittance." The preliminary work on a helmet model includes the spreading and shaping of a rough mass of soft Swedish iron with blows of a drawing hammer, one of the Museum's collection of authentic armorers' tools. The finishing touches are given on a long-armed anvil known as a drawing stake.



Frequent measurements are taken and recorded by the armorer to insure proper contours and sizes. Above, a workman is measuring a model to determine a place for earpieces

Behind steel doors in a secret workshop a skilled artisan is using a four-century-old drawing hammer and drawing stake to put the last touches on a new experimental iron headgear



TAKE-OFF. The world's biggest operating plane taxis through a choppy sea before lifting her more than 75 tons of weight into air

The Mars Makes Good

Glenn L. Martin's flying freighter joins the Navy and proves her mettle on a first flight to Hawaii.

By ALFRED H. SINKS

PEARL HARBOR, HAWAII

WE DIDN'T come out to Hawaii just for the ride. We wanted to get the feel of the peacetime airways that will circle the globe after the war is won. We wondered what kind of ships will take the long water hops on those future trips. That's why we jumped at the chance when the Navy offered us permission to take this particular trip. It was the first transocean flight in regular service of the giant seaplane Mars.

Every one of the 35 people aboard the huge flying boat had a few lurking doubts as she cast off her moorings at the Alameda Naval Air Station on San Francisco Bay. Only a fool would be confident on the maiden voyage of any ship of radically new design, and the Mars is by far the biggest aircraft

in regular service. One hundred seventeen feet from stem to stern, 200 feet from wing tip to wing tip, the huge whale-shaped hull designed by Glenn L. Martin's engineers has as much room inside as a 15-room house.

The Navy's biggest "flying boxcars," the Coronado PB2Y's, are only a little more than half her size. It would take three giant Douglas C-54's to move as much freight or as many passengers as the Mars can tote on a 2,500-mile hop. It was a lot of airplane that Skipper Bill Coney had to lift off of San Francisco Bay on that clear evening of January 22—about 75 tons of plane, gas, crew, and cargo.

We cruised south over the surface of the bay with the four big Whirlwinds still warming. They are of a new type perfected during the Mars' first trials. Then the skipper brought her about, and we picked up speed

as the nose pointed north. The ship bucked gently against the waves slapping her bow.

We passengers were snug in the after compartment, lower deck, behind the last but one of seven watertight bulkheads that divide the deck into compartments. High above us and forward on the flight deck, Lieutenant Hamilton, the chief engineering officer, must have pulled all four throttles wide open. The four engines gave out with the full roar of more than 9,000 horsepower.

The interphone gave warning: "Stand by for take-off."

The starboard ponton lifted clear of the water. Up in the cockpit Skipper Coney was trying her for balance. Spray blanketed our portholes. The wings wagged once as we lifted into a quartering wind, then all feeling of motion ceased. There was only the roar and vibration of the engines. The take-off was perfect. Seasoned flyers were amazed at the ease with which the big sea bird took the air.

But, just to remind you that the Mars is a big ship, that take-off run was a mile and a half long. And, just to remind those of us aboard that she was a new ship with her reputation still to make, a regular Navy seaplane tailed us all the way across—just in case.

The sun had dipped behind the Golden Gate before we left the water, but at 5,000 feet we saw it again. At that altitude—though the skipper is firm about keeping his ship in perfect balance—we could shuck our life jackets and begin to move about the ship by twos and fours.

Because of her sheer, overpowering size and the uncanny steadiness of her flight, it's hard to remember at times that the Mars is not a ship but a plane.

As you leave the waist compartment and move forward along the main passageway of the lower deck, you enter the galley through a watertight bulkhead. Another bulkhead, and then a bunk room. Forward of that is the main cargo hold with five tons of

precious war material lashed tight on either side of the passageway. Then the fueling compartment, from which lines lead to the fuel tanks under the lower deck. Together the tanks have room for as much high-octane gasoline as a fully loaded tank car.

Forward of the fueling room is another bunk room. To port is a fully equipped washroom and shower; to starboard, a ladder that leads to the flight deck above. Up in the nose, under the flight deck, are well-appointed quarters for the officers.

The Mars has an interesting history—and shows it. Her keel was laid at Baltimore before Pearl Harbor, but she had been planned originally as a long-range bomber. With a theoretical range of 8,000 miles, she might have been able to take off from Hawaii, drop 20 tons of bombs on Tokyo, and return to Pearl Harbor, but the lessons of blitzkrieg taught that a bomber has to be something besides a big truck.

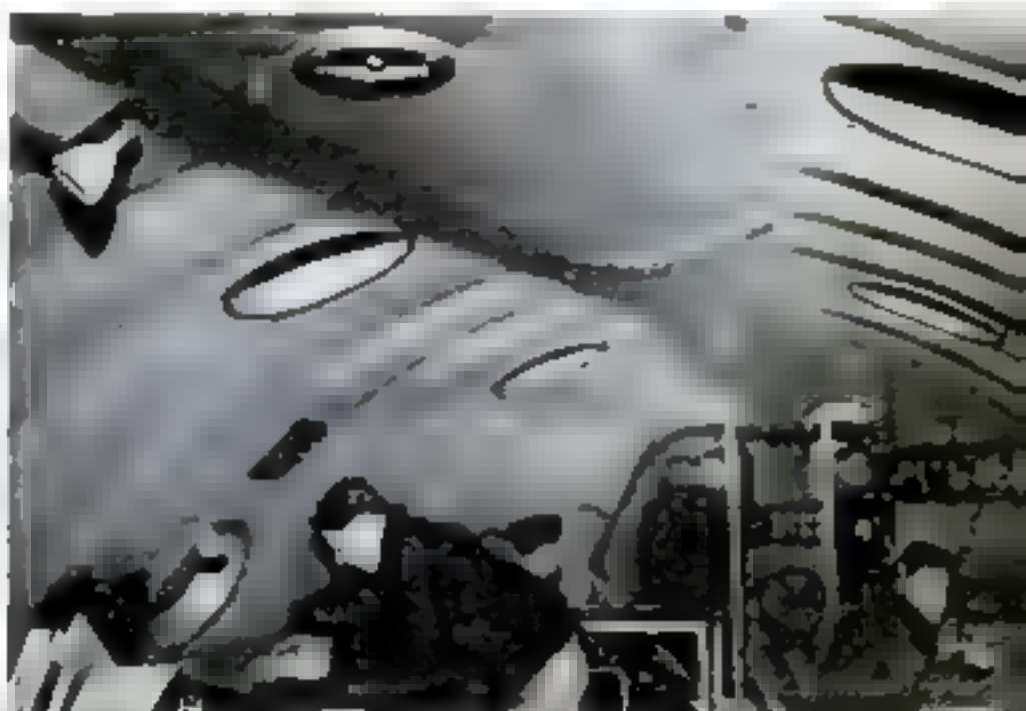
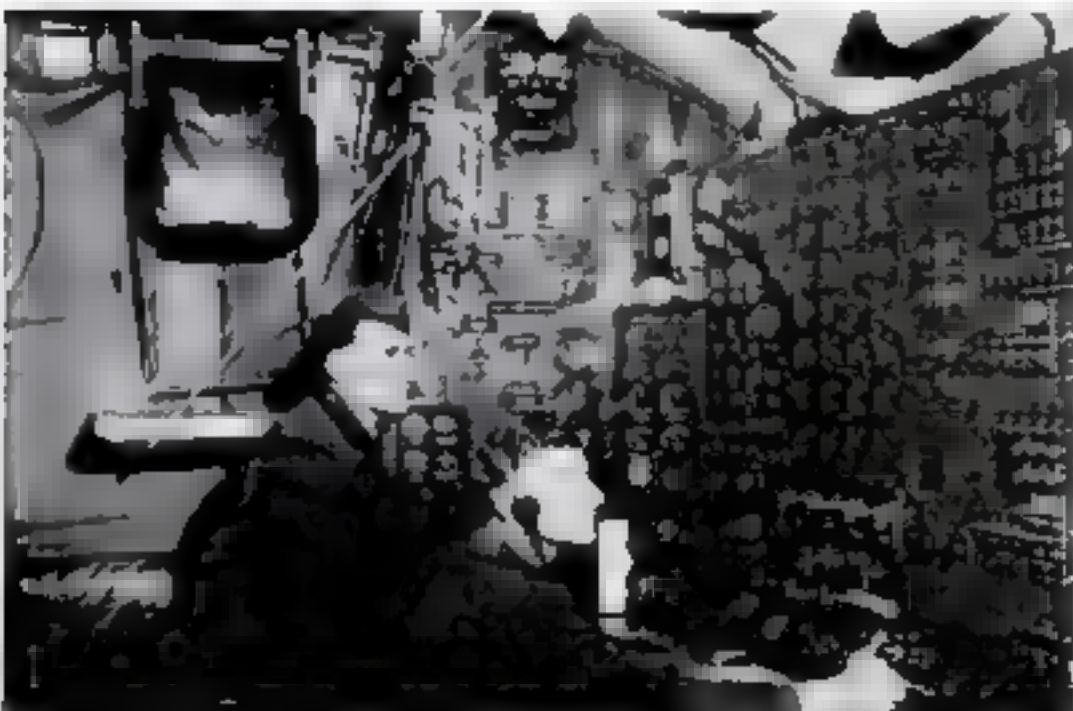
The Mars is not a particularly fast ship; she hasn't nearly the speed of one of the newest Fortresses. So the big bomb bays in her wings were changed into cargo holds. Next, the Navy had her marked for personnel transport. Finally, she proved perfect as a heavy freighter with room for plenty of passengers in addition to cargo. Today she carries no armament, but the machine-gun blister out in her tail is a reminder that she has been a flying laboratory for the lessons of modern war.

As a result of that history of trial and error, more ships of the Mars type will soon be coming from the production line. A score of them will eventually join the Navy's NATS squadrons—the force that rushes Navy men and vital material out to the battle fronts far from home.

You can go up inside the wings, where the bomb bays were to have been. You climb a gangway in the waist compartment. Upstairs you find yourself in a bunk room. In a second bunk room forward is a short flight of stairs. At the top, you open a

On the mammoth flight deck, the flight engineer and his assistant watch the panels on which about 150 dials and controls cover all the working parts

The flight deck is bigger than the fuselage of an ordinary transport. Navigator and radioman are at their posts, pilot and copilot up in the cockpit





IN THE AIR the Mars looks like a giant whale that has grown wings. Measuring 117 feet in length, with a 200-foot wing span, she has the cubic capacity of a 15-room house. The Navy has ordered 20 more of these flying freight cars for carrying critical war cargo and personnel

bulkhead and ease yourself gingerly inside, above the fuselage. You can stand without stooping inside the wing. Once each hour one of the 15 crew members climbs up here; makes his way among the tubular internal braces of the wing; inspects engines and fuel, oil, and ignition lines; looks over the hydraulic pressure lines that operate the "booster" on the automatic controls.

The more you see of her, the more the size of old "Moby Dick" impresses you. You keep comparing the size of things with that of the equipment of ordinary planes. Every so often you have to stop and remind yourself that the big winged whale is really purring along over the Pacific, cruising at between 8,000 and 9,000 feet, smooth as a Buick rolling over asphalt, quiet as an average "stateside" airliner, though only parts of the ship are soundproofed.

Somewhere out over the Pacific, Lt. Ken Winsor, the third pilot, drops down to the waist compartment for a smoke.

"Anybody here seen my flight jacket?" he asks. Passengers and crewmen shake their heads. "See this." He takes off his knitted scarf. "I just found this after a month." Yes, you can lose your stuff on a ship as big as the Mars.

It's up on the flight deck that the really important work goes on. With plenty of headroom, it's as big as an average living room. As you step off the ladder, the engineer on duty sits at your left with his back to you, facing two panels loaded with about 150 dials and controls. Up ahead of him, the two navigators work over their charts and

data spread over a table seven feet long by three wide. Still farther forward is a small work table for the flight engineer, and over to the right sits the radioman. Because the lights burn all night on the flight deck, a black curtain separates it from the cockpit up in the nose. Aft is a turret not unlike the top turret on a bomber, where the navigator can get a fix on a star in any direction. Standing up there, you feel you have never been so close to the stars. Besides those stars, only the tail light, the violet flame pouring from the exhaust ports, and the red-hot exhaust manifolds remind you where you are.

Some of us expected excitement on the Mars' first Pacific flight. We were disappointed. The ride was as smooth as velvet. Even when we went up to 9,500 to ride over the top of a storm, there were hardly enough bumps to remind us that we were in an airplane. The Mars, say all three of her veteran pilots, handles more easily than any other plane they ever flew. They boast that she can climb with a full load on any two of her engines, and she can land with all of them cut out.

Incidentally, Bill Coney is a former flight captain for Eastern Airlines, and his two copilots on the Mars flew with him in commercial airline work.

This was the skipper's first flight to Hawaii, and he wanted to set the Mars down in daylight. She's the first of her kind, far too valuable to take chances with. In many ways, she's still a flying laboratory piling up valuable data. (Continued on page 204)



No Supermen Needed

Flying the new jet plane
is as simple as handling
a primary trainer, say
pilots who have done it

By C. B. COLBY

Popular Science Aviation Editor

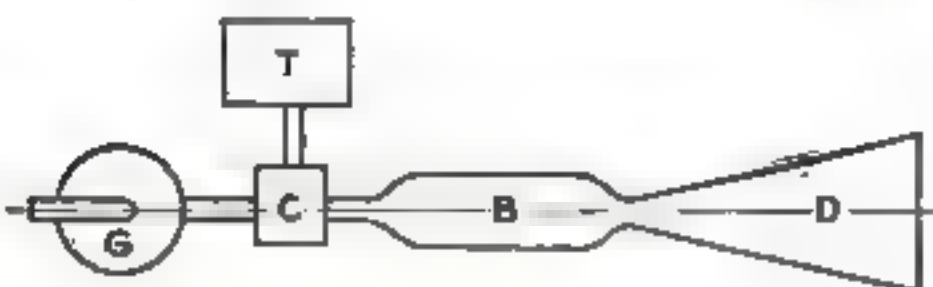
ANNOUNCEMENT of the Bell jet-propelled plane has set off a train of speculation as to what special training will be required by our pilots before they can handle this new type of aircraft in combat.

Jet-propelled aircraft — sometimes erroneously called "rocket planes," immediately suggest to the layman flame-trailing, bulletlike aircraft piloted by supermen specially prepared for this nerve-racking work after months of conditioning and training on the ground. Bunk!

— Brig. Gen. C. W. Chidlaw, Chief of the Army Air Forces Material Division, after flying this amazing ship, said: "Our pilots will find no trouble in operating these planes." Others who have flown it have made similar reports.

Are they covering up real difficulties? Let's analyze what has been said

THIS IS THE PRINCIPLE OF HOT-AIR JET PROPULSION



This drawing from the magazine "Flight" shows the principle of most jet engines. The air enters the rotary blower (G) and is compressed. Flowing into the carburation chamber (C), it is mixed with fuel from the tank (T). In the combustion chamber (B), the mixture is ignited and the blast of expanding, heated air is ejected through the blast tube (D).

about this plane and what has been published about jet propulsion, and see what flying one of these ships must be like.

The men who have looked forward to Buck Rogers experiences in these craft will miss all the characteristics popularly associated with so-called rocket flight. There is no lurching, roaring, flame-trailing whizz; no vibration and straining of structures.

Were powder rockets used as propellants

in the Bell aircraft, such things might be a part of the picture, but this craft is propelled by a jet of air alone.

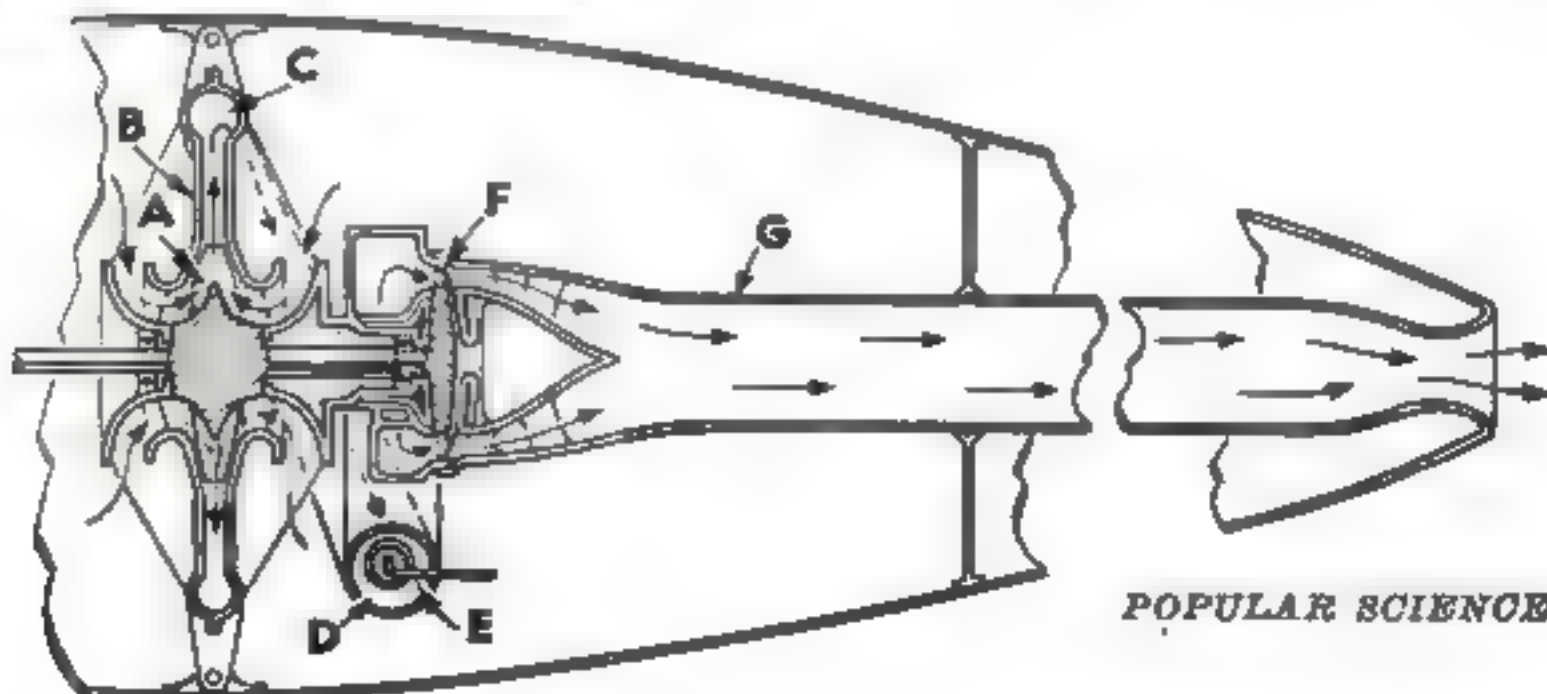
The engine, designed by Wing Commander Frank Whittle of the RAF, was first used successfully in a plane built for its use by the Gloster Aircraft Company of England. The engines used in the Bell plane are assumed to be of similar design to Whittle's early models, although all details are secret. His unit designed in 1933 consisted of a simple, compact air compressor into which the atmosphere poured from the forward end. After compression it was heated, augmented by additional burning fuel (reported in the press to be kerosene), and finally discharged from the aft vent in a monstrous jet of energy pushing against the atmosphere. This backward push produced the equivalent in forward thrust.

Full details of this engine were disclosed to the U. S. Army Air Forces in July 1941. The AAF at once asked for a specimen engine for experimentation, and one was sent to this country. It was turned over to the General Electric Company, which worked closely with our Matériel Command and the Bell Aircraft Corporation to develop



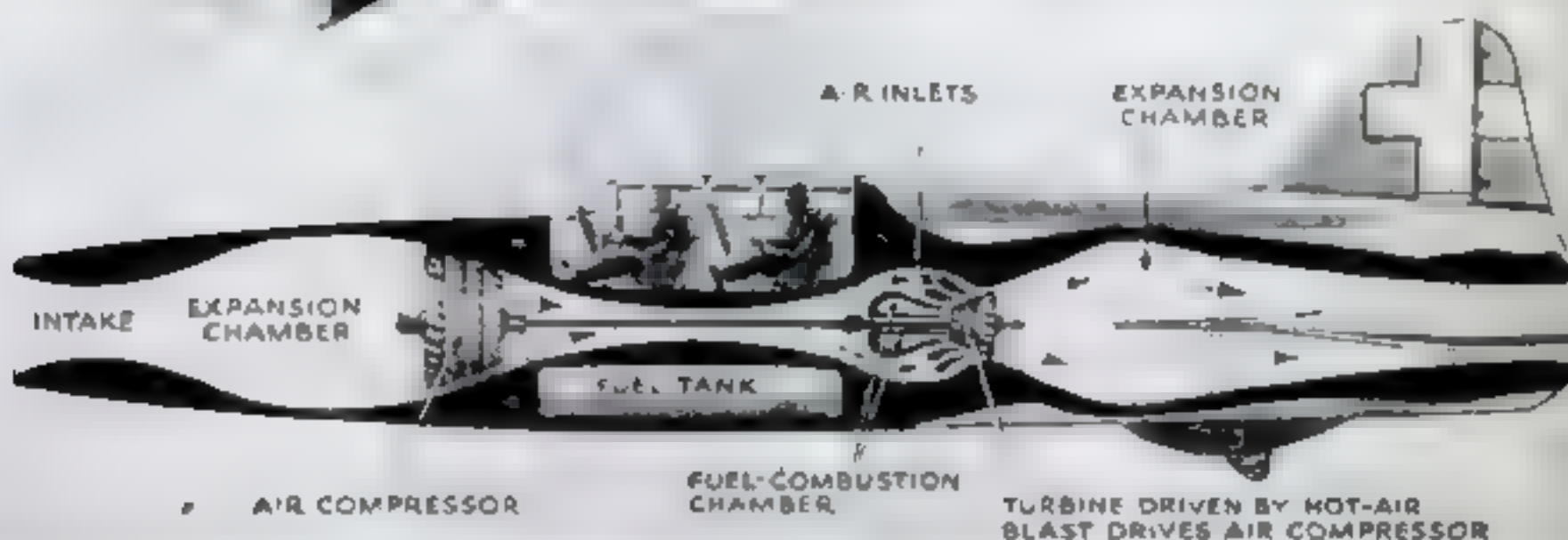
DEVELOPER OF JET ENGINES . . . AND AN EARLY DESIGN

Wing Commander Frank Whittle (left), of the RAF, began work on the development of jet propulsion in 1933. In 1937 his preliminary test model ran successfully, and two years later the Air Ministry placed its first order for a jet-propelled plane. First flight was in May 1941. So secret was the work that Whittle's own family learned of his connection with it only upon the announcement of the American and British jet planes in January 1944. The drawing below, also from "Flight," shows one of Whittle's early designs. Air enters the impeller (A), whose spinning blades direct it into the radial diffuser chamber (B). Next it flows through the scroll (C) to the combustion chamber (D). Here fuel injected by the tube (E) is ignited to increase the expansion of the air, which turns the turbine rotor (F) to drive the air compressor. The main blast passes directly to the blast tube (G) and is discharged through the tail of the unit.



THE ITALIANS TRIED IT, TOO

As long ago as 1940, a jet-propelled plane was test-flown in Italy. In the following year, this Caproni-Campini CC-2, designed by Secondo Campini, flew from Milan to Rome. However, it did not attain high speed and had to land en route, apparently to refuel. After this flight, nothing more was heard of it. The drawing below, from the May 1942 issue of P.S.M., gives our artist's idea of how the CC-2 worked



the plane and engine that we now have.

And now about its flight:

Frank H. Kelley, Bell Aircraft Corporation test pilot says: "It is the smoothest ride I have ever experienced in any plane. The first time I climbed into the cockpit, I was naturally a little nervous about first contact with an entirely new method of propulsion. My nervousness persisted while I started the engines and until I began to taxi across the field for take-off, when it dawned on me that this plane was even simpler to operate than a primary trainer. I flew it through all maneuvers for 20 minutes, and then landed and taxied up to the line.

"I wanted to check the fuel before resuming flight, and so, before turning on the main switch to read the electrical gauges, I stuck my head out of the cockpit and shouted to warn the mechanics to stay clear of the propeller, completely forgetting that I didn't have any propeller."

Let's see how all this can be—how one

can forget that there are no propellers, why operation can be "even simpler than a primary trainer," and why the outstanding thing about this jet plane is its ease of operation by pilots.

As seen in the illustration on page 85, from a Bell announcement, the plane is of almost conventional appearance except for the absence of a propeller and the addition of certain structural features to accommodate jets. Standard appearance indicates standard controls, which in turn make transition a simple matter for the GI military pilot.

The landing gear is of the latest approved tricycle type. Steerable nose wheel, brakes, and good visibility should make the ground handling of the craft no different from that of orthodox aircraft.

The instrument board would naturally be simpler than that of the regular twin-engined military craft with its myriads of engine and flight instruments. With the possible excep- (Continued on page 808)



"MINE READING." Disarming an Axis land mine is a tricky business even in broad daylight. Doing it in the black of night is a heart-in-throat job that calls for the deft touch of a steel-nerved pickpocket. To train their sappers in this hazardous work, British forces in Italy have devised the

"Moascar stocks"—walls with burlap-shielded holes through which men thrust their arms and, guided only by their sense of touch, practice taking enemy mines apart. Instructors on the other side of the walls are quick to point out any mistake, which in combat might prove to be the sapper's last.



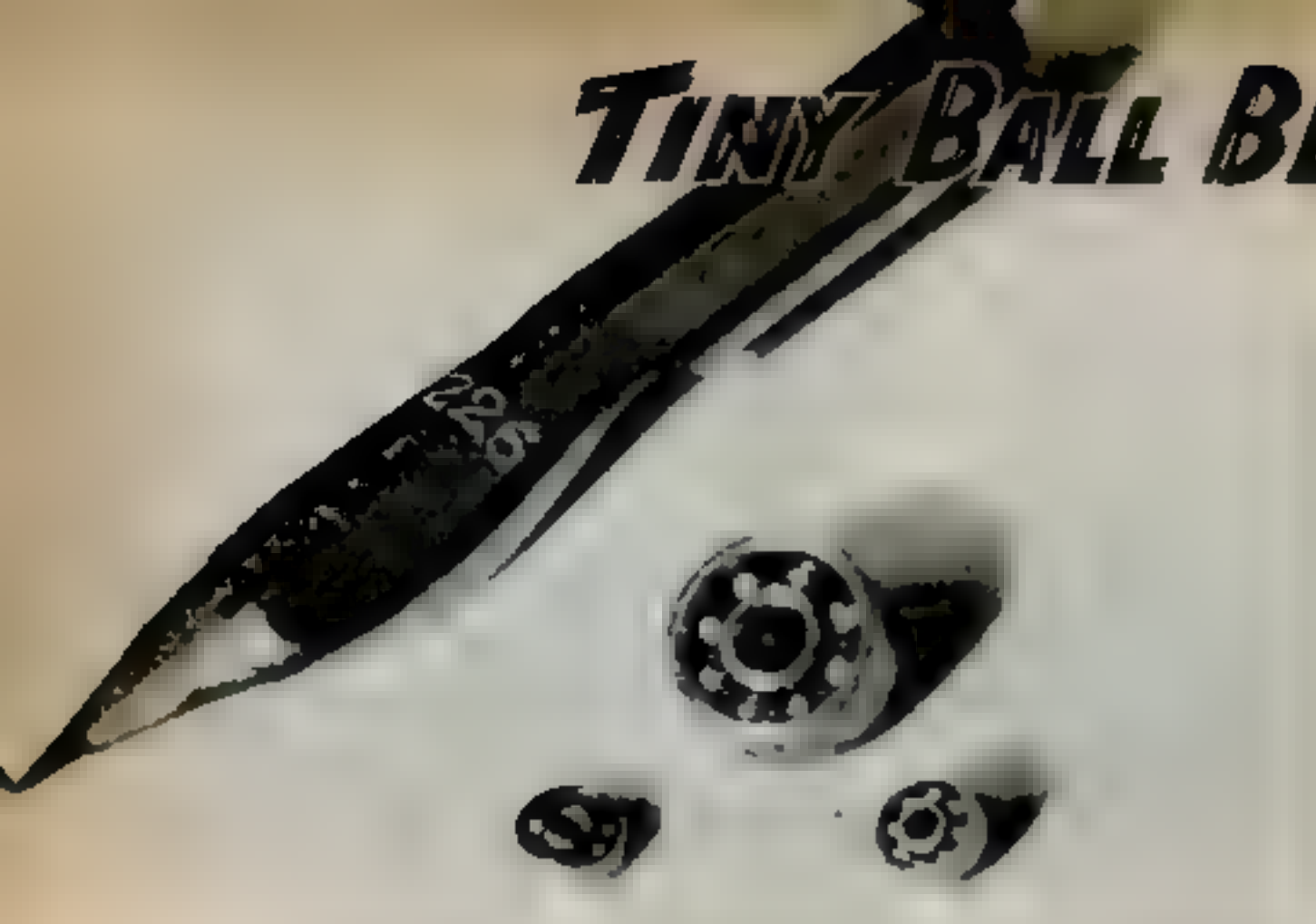
VOUGHT CORSAIR (F4U) U. S. NAVY FIGHTER

PAINTED by Jo Kotula, this month's full-color pin-up painting of a U. S. warplane features one of the "hottest" ships in the air—the carrier-based Corsair. Easily identified by its inverted "gull wings," the F4U, with a top speed of 400 m.p.h., is the Navy's counterpart to the Army's fast and powerful Thunderbolt.

NEXT MONTH: BELL P-39 AIRACOBRA



TINY BALL BEARINGS



How $\frac{1}{8}$ and $\frac{1}{16}$ -inch ball bearings—pivotal parts of war instruments—look next to a pen nib. They are shown here magnified two and a half diameters

By
**JEAN
ACKERMANN**

SO TINY that it takes 111,111 to make a pound, miniature precision bearing balls play a vital part in our war machine. Set in flawless steel rings, some of which are hardly larger than a pinhead, they are pivotal parts of such instruments as the pilot's gyro-horizon (artificial-horizon indicator) and autosyn motors (informers on

ailerons and retractable landing gear); they serve in the compass of a ship and in bomb-sights. On their proper functioning may hinge the outcome of a bombing run or a sub chase.

Precision operation means friction-free rotation under pressures as light as an ant's tread, for the value of precision bearings



1 Precision machining of miniature bearings is done on a rubber-bonded abrasive wheel. A groove for a race is ground in a $\frac{1}{4}$ -inch ring



2 Then the ring is polished with abrasive paper until it shines like a mirror. Tolerances in this work must be kept as low as $1/100,000$ inch

5 Balls are fed into assembled inner and outer rings from a ladle that picks up the number required. The operator must wear gloves



6 Holding a bearing in a gloved hand, a worker turns it on a hollow arbor that magnifies drag and roughness so it can be felt by the other hand

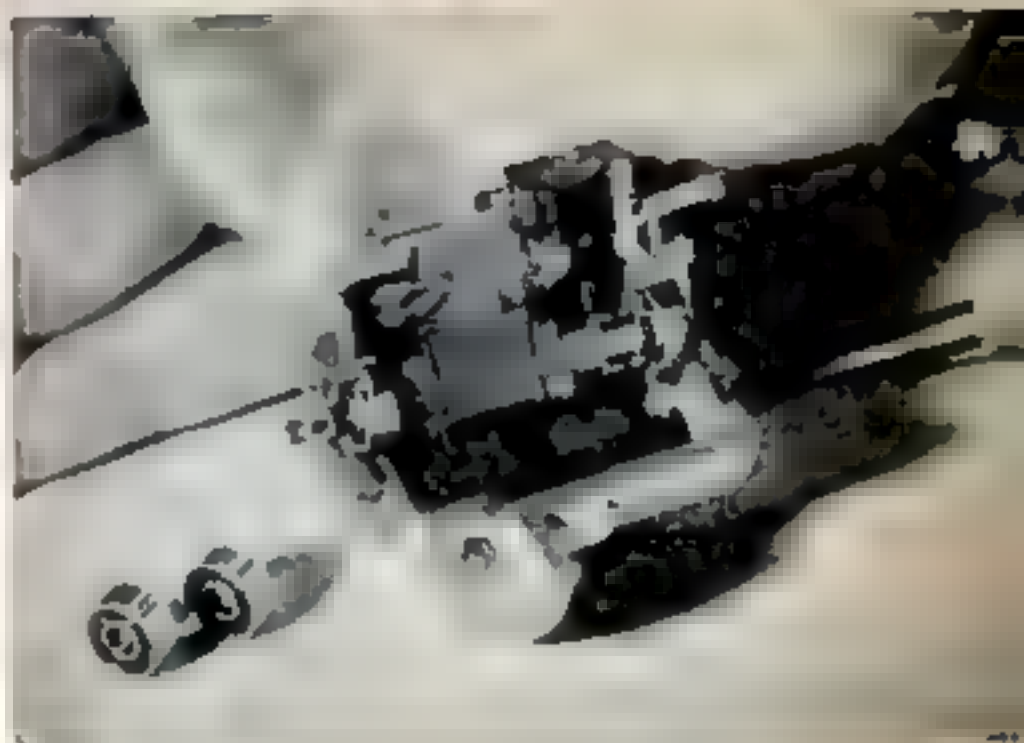


SPEED OUR WAR MACHINE

lies not only in their strength, but in sensitive, accurate mechanism. To achieve the requisite balance and precision, balls and races—the latter ranging from less than $1/8$ to $5/16$ of an inch in outside diameter—are ground to tolerances as slight as $1/100,000$ inch. And after grinding, the bearings are literally handled with kid gloves until they reach their ultimate user, for friction is caused by infinitesimal objects. A microscopic flake of dust, a breath of lint, or a spot of perspiration might irreparably upset the sensitive balance.

The finely made parts are brought to a dust-free laboratory for cleaning, gauging, and assembling. At the door, the operator carrying them must don a smooth-fibred smock that won't shed fuzz, and wipe her shoes on a gelatin door mat that snares the most feathery dust. Data sheets accompanying the parts are slipped into cellophane envelopes lest they scatter lint. To move a bearing, a worker puts on kid gloves or uses small tweezers—no ball or ring is touched by human hand after machining.

This is carrying carefulness to the extreme, but it has paid high dividends. There



Two tiny bearings are used in each of the autosyn motors that keep tabs on important plane elements

are cases on record of bearings turning in top performance over many years without showing the least signs of wear. The accompanying photos from the New Departure Division of General Motors, and from *Grits and Grinds*, a Norton Company publication, show how some sizes of the miniature bearings look and how they are made.



3 The bearing balls, also ground flawlessly, are rolled gently into a funnel-shaped container to be thoroughly cleansed with a filtered solvent



4 Work-classification tickets that accompany the parts are put in cellophane to keep even minute dust and lint from touching the bearings

7 Bearings get a shot of oil from a regulation hypodermic needle—one or more drops may be required. This lubricates them and prevents rust



8 Finished bearings are carefully wrapped for shipping—here ten to the roll. Not even the cellophane is touched by the operator's bare hand



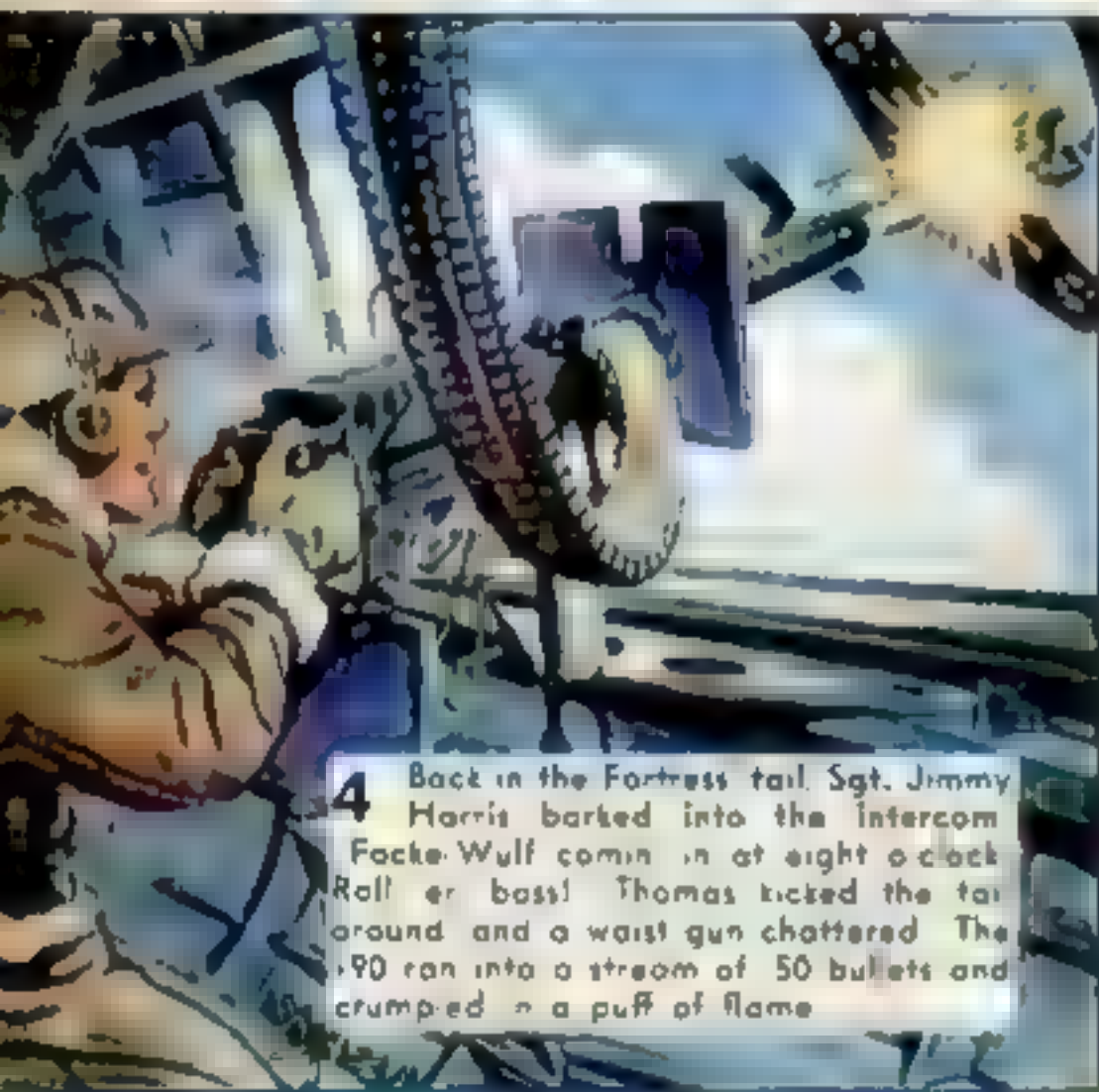
They Wouldn't Bail Out!



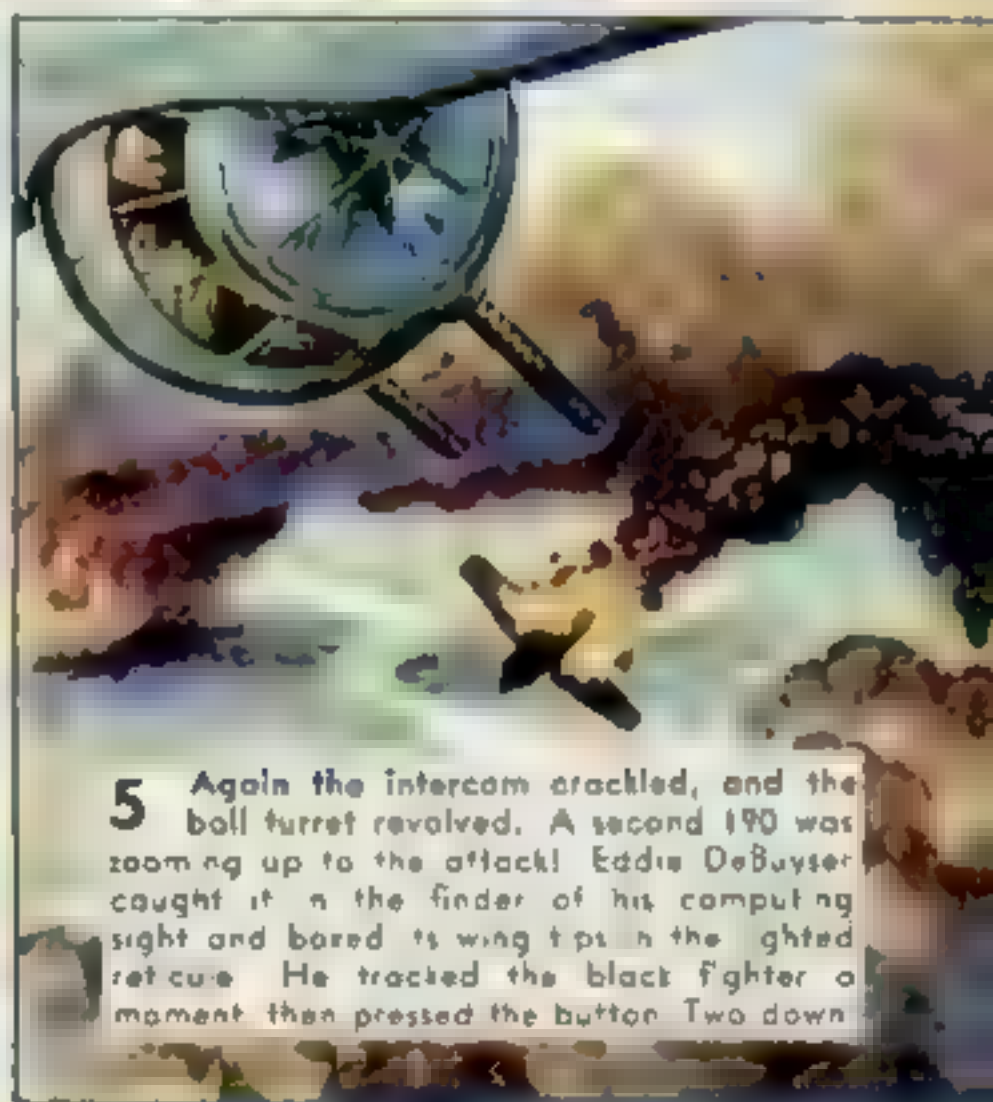
The B-17's can dish it out. That's their job. But Boeing's big babies can take it, too! Pitted against the best that Goering and Tojo can throw against them, they have proved repeatedly that fighting American boys and rugged American planes make a combination that is hard to beat.

By FRANK TINSLEY

1 Listen to the story of "Wanda Bird" as told by Lt. Woodrow W. Thomas, a Fortress pilot of the Eighth Air Force. Our target was a key industrial plant near Kassel, Germany. It was fringed with ack-ack guns, and Jerry began throwing heavy flak at us as soon as we got in range.



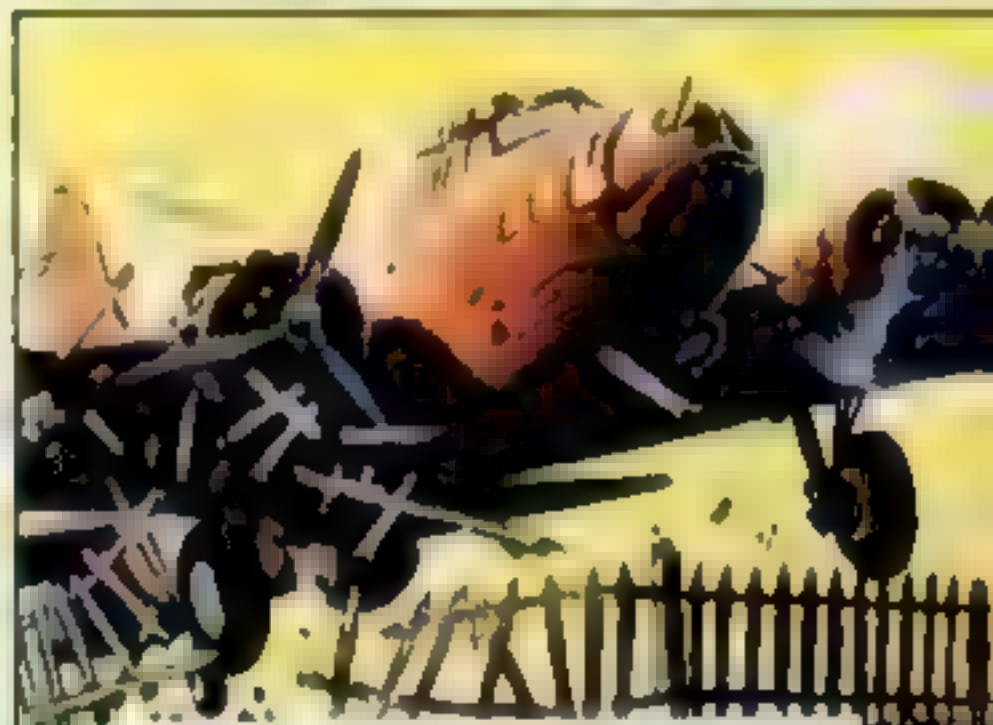
4 Back in the Fortress tail, Sgt. Jimmy Harris barked into the intercom: "Focke-Wulf coming in at eight o'clock! Roll 'er boss!" Thomas kicked the tail around, and a waist gun chattered. The 190 ran into a stream of 50 bullets and crumpled in a puff of flame.



5 Again the intercom crackled, and the ball turret revolved. A second 190 was zooming up to the attack! Eddie DeBuyser caught it in the finder of his computing sight and bored its wing tips in the sighted reticle. He tracked the black fighter a moment, then pressed the button. Two down.



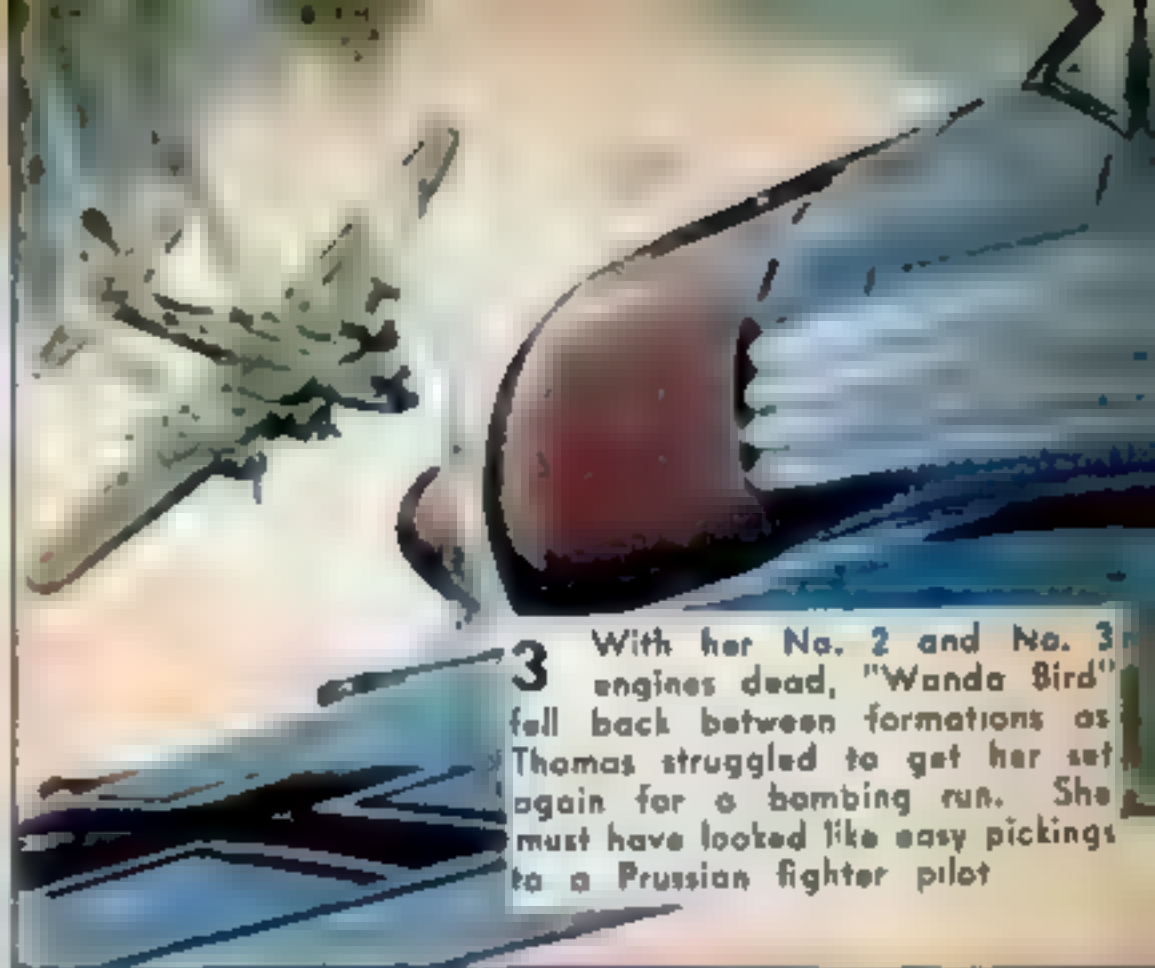
8 Limping back across the Channel to England, Thomas heaved a sigh of relief when he sighted a landing field. But, just as his wheels were about to touch the ground, he saw that the runway was torn up! Hauling back on the controls, he barely cleared a near-by hill when his No. 4 engine sputtered, coughed, and quit!



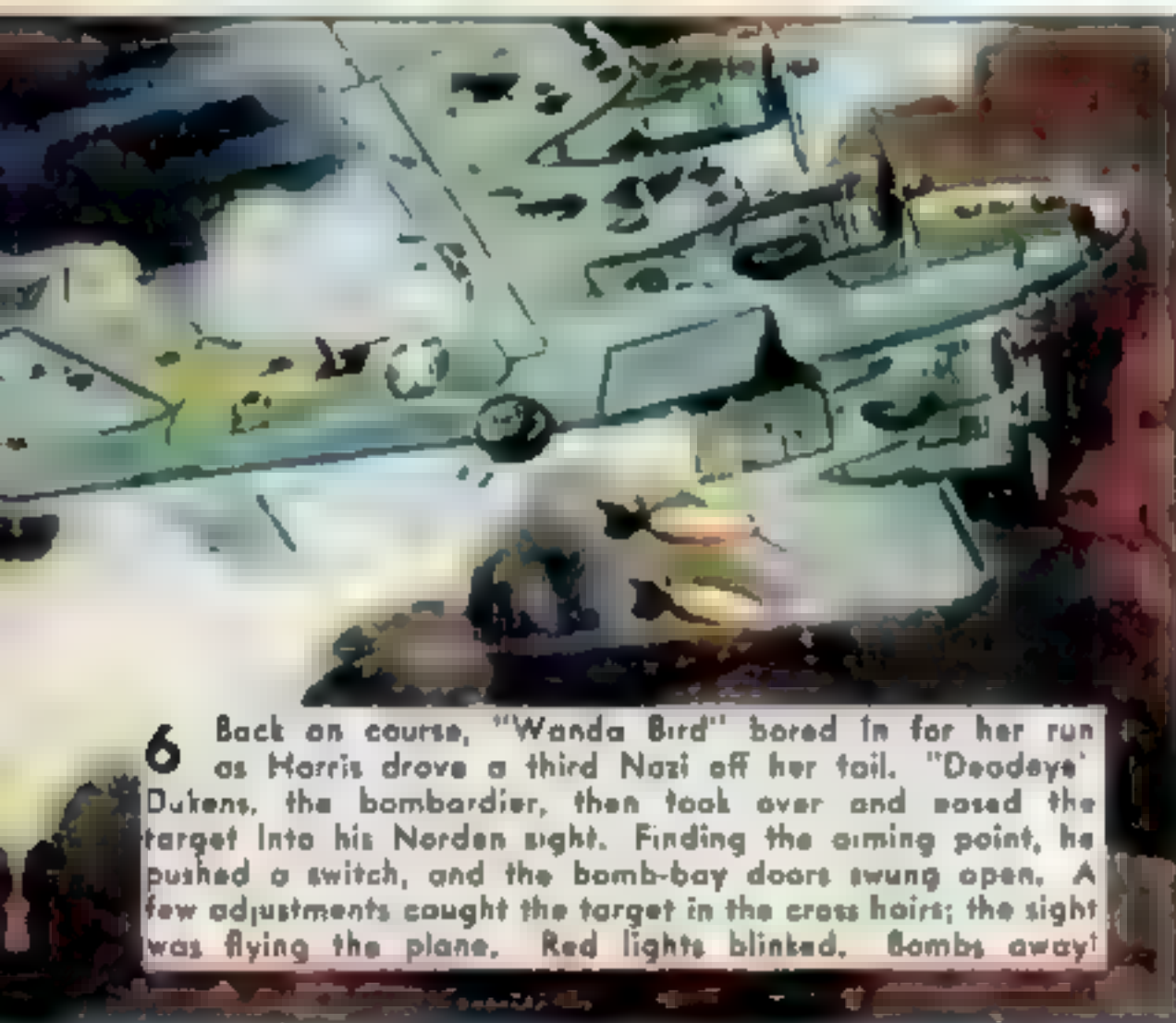
9 Spotting a pasture ahead, he set his teeth and stretched out "Wanda Bird's" glide. The big girl responded gallantly. Snapping a sizzling high-tension line, she smashed through a fence, sending the pickets flying, and hit the turf rolling.



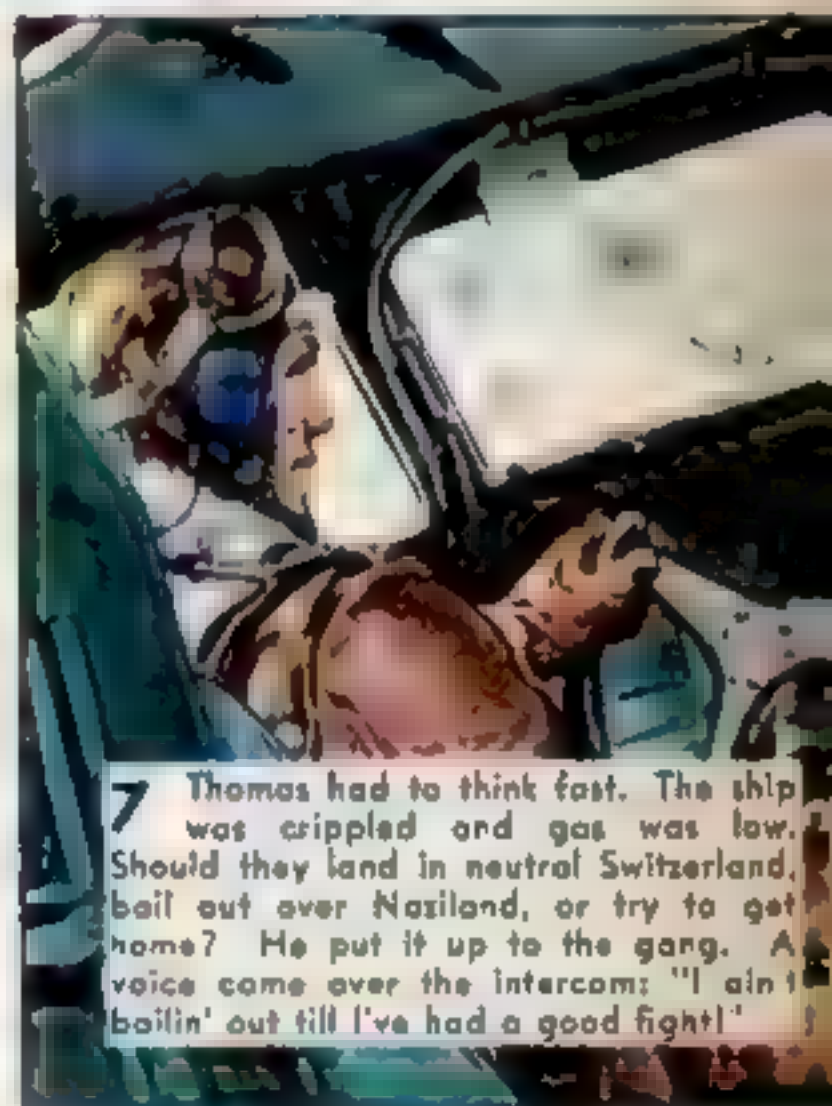
2 We were jockeying into position for our run when 'Wanda Bird' was jolted by a rending crash! She dropped 3,000 feet before I could regain control and look around. The starboard wing was a flat-mangled mess!



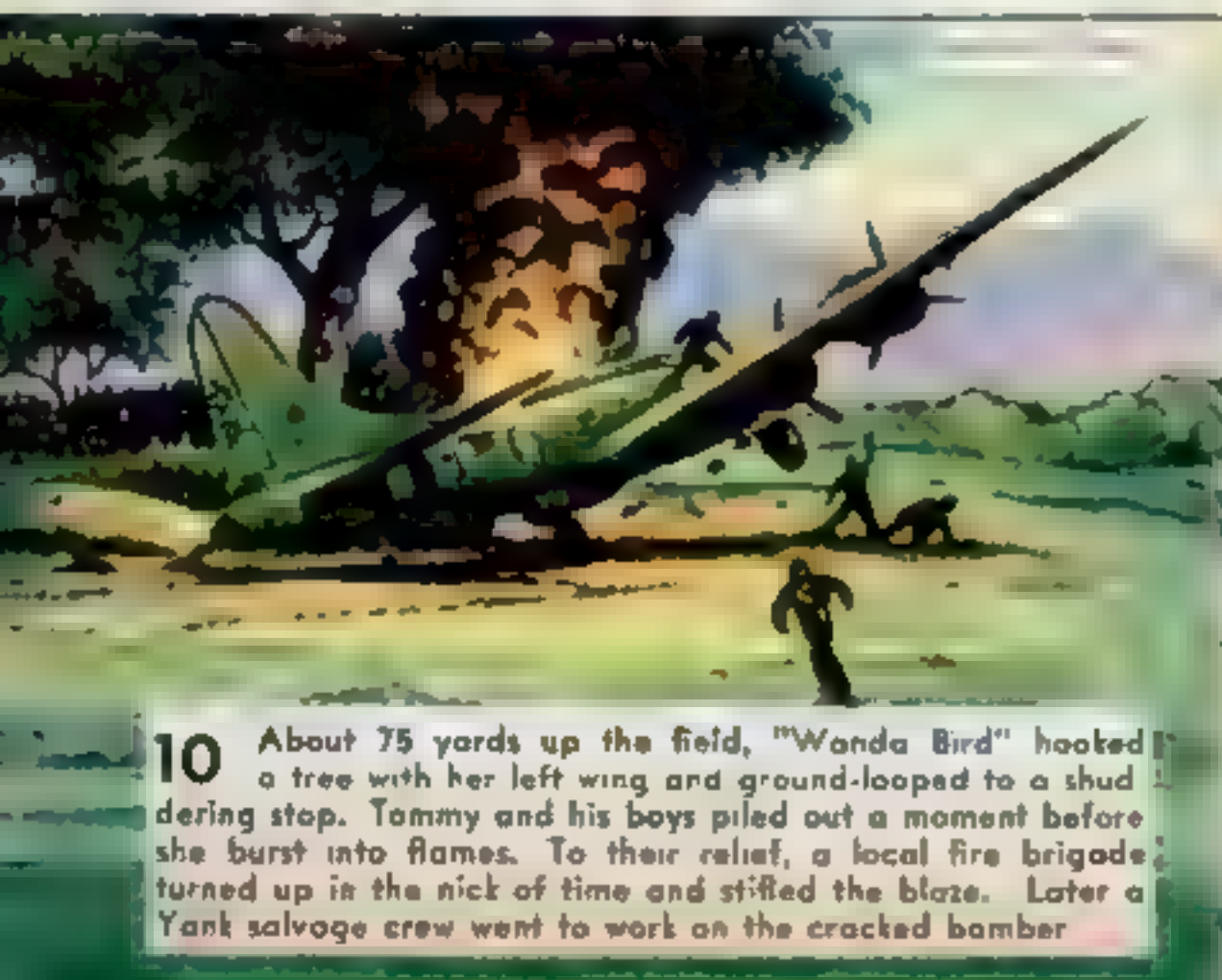
3 With her No. 2 and No. 3 engines dead, 'Wanda Bird' fell back between formations as Thomas struggled to get her set again for a bombing run. She must have looked like easy pickings to a Prussian fighter pilot.



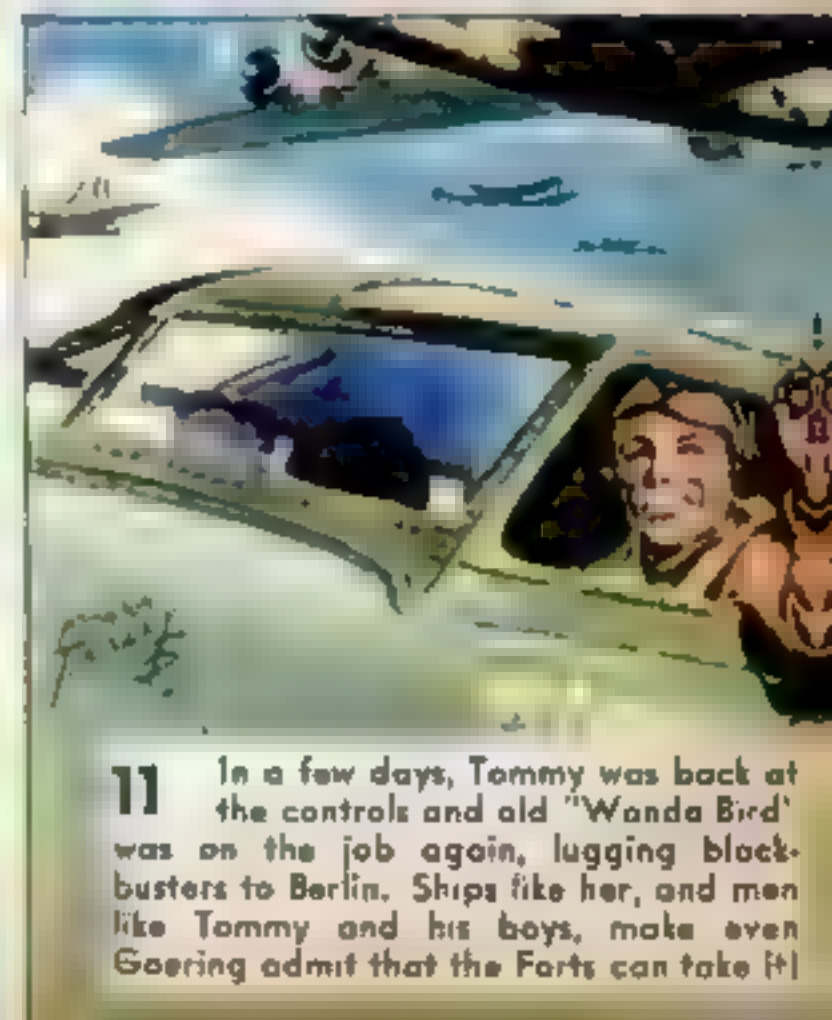
6 Back on course, 'Wanda Bird' bore in for her run as Harris drove a third Nazi off her tail. 'Deadeye' Dukens, the bombardier, then took over and eased the target into his Norden sight. Finding the aiming point, he pushed a switch, and the bomb-bay doors swung open. A few adjustments caught the target in the cross hairs; the sight was flying the plane. Red lights blinked. Bombs away!



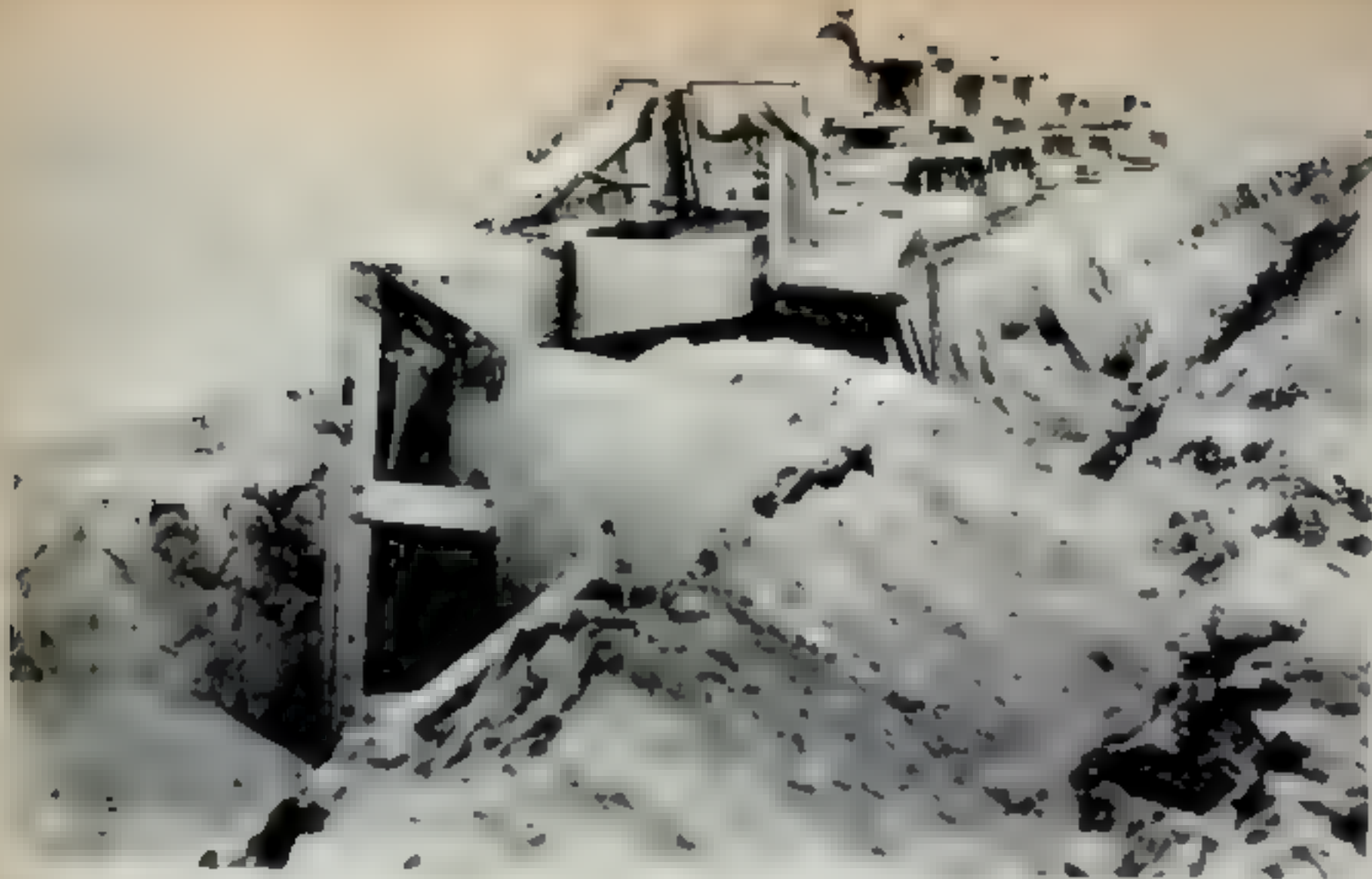
7 Thomas had to think fast. The ship was crippled and gas was low. Should they land in neutral Switzerland, bail out over Naziland, or try to get home? He put it up to the gang. A voice came over the intercom: 'I ain't boilin' out till I've had a good fight!'



10 About 75 yards up the field, 'Wanda Bird' hooked a tree with her left wing and ground-looped to a shuddering stop. Tommy and his boys piled out a moment before she burst into flames. To their relief, a local fire brigade turned up in the nick of time and stifled the blaze. Later a Yank salvage crew went to work on the cracked bomber.

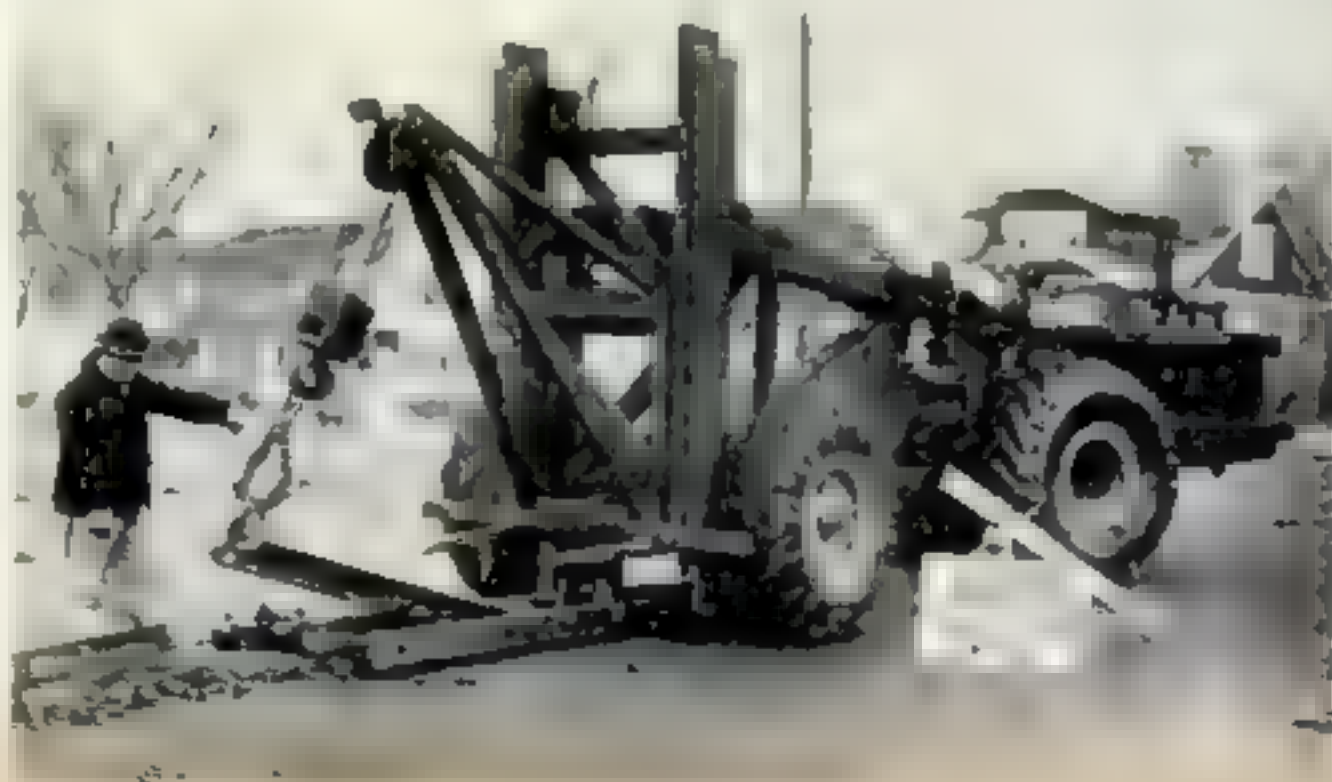


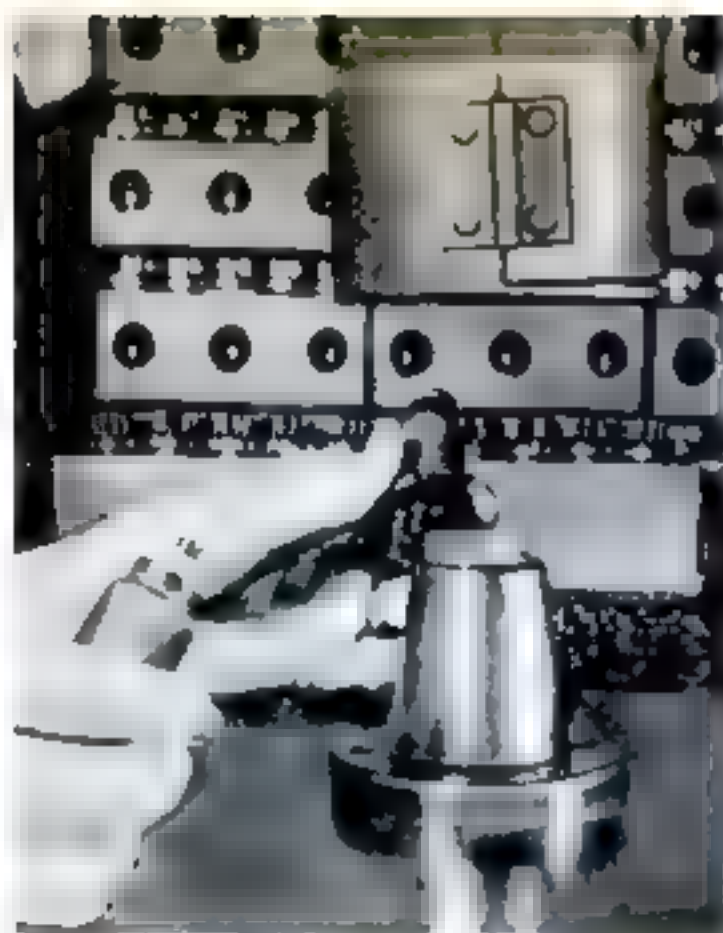
11 In a few days, Tommy was back at the controls and old 'Wanda Bird' was on the job again, lugging black-busters to Berlin. Ships like her, and men like Tommy and his boys, make even Goering admit that the Farts can take it!



SIX-FOOT FURROWS are cut by this giant plow, a seven-ton monster with a share as tall as a man. The world's largest plow, it was built by Post Brothers, of Santa Ana, Calif., to turn up rich soil that had been covered by two to three feet of sand deposited by a flood. It is pulled by five Diesel tractors developing a total of 400 drawbar horsepower and will plow a half acre an hour at full depth. In restoring the fertile valley after a flood of the Santa Ana River, the plow was operated by crews in shifts for an average of 20 hours a day.

RAILS COME UP without disturbing near-by brick pavement when jerked by a wrecker developed by boiler-makers of the R. G. LeTourneau, Inc., war plant for the Peoria Ill., Junior Chamber of Commerce scrap drive. The "Tournajerk," operated by one man, has a 60-ton pull and, in removing 15 blocks of tracks, outdistanced a patching crew cementing the openings it left.





ALIGNING RINGS. Synthetic resin used in clinching tube parts lasts three weeks, where rubber was replaced often



WRIST PROTECTOR. A shield of the resilient synthetic, highly resistant to abrasion and wear, guards an operator's arms while he cleans small parts in a sandblasting machine

Pinch-Hitting for Rubber

SELECTED first in experiments for a substitute when the supply of natural rubber was threatened, a resilient synthetic-resin compound is now being used by the RCA Manufacturing Co. in over 15 war-industry operations. And in nearly every case this new substitute has been found to outlast the original by far.

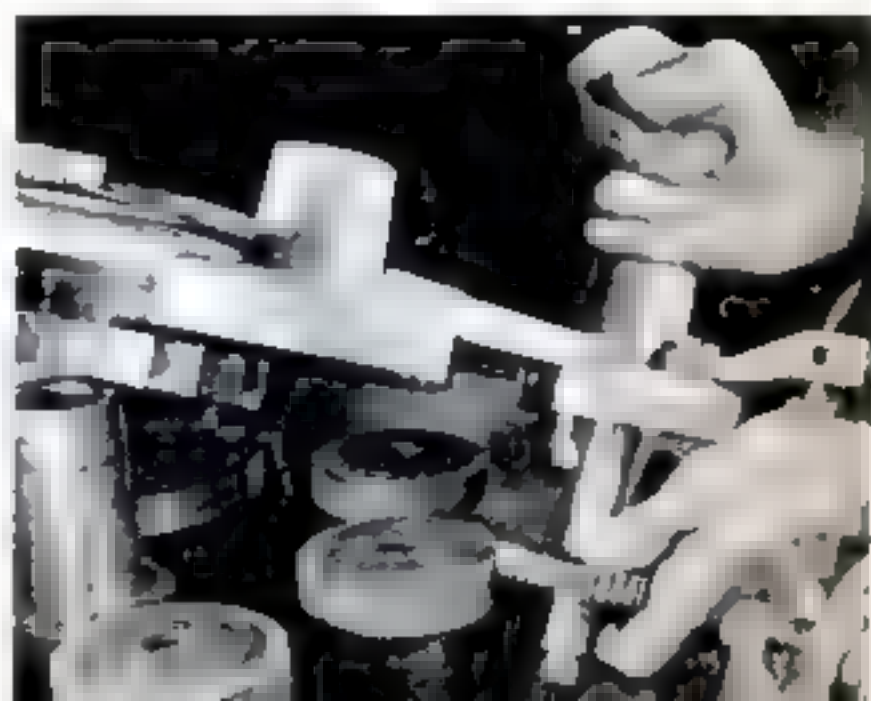
The compound, developed by the Resistoflex Corporation, is resistant to many solvents that attacked rubber, has exceptionally low permeability, is extremely tough, and stands up under both flexing and abrasion. It is fabricated in 1/8 and 1/16-inch sheets from which pieces are punched and then laminated into washers, spacers, rollers, and other small parts. Final processing is done on standard shop equipment without special presses or molding devices. The material also replaces some metal tubing.

FORMING-PRESS JAWS. A lining of sheet synthetic resin is cemented directly to the metal faces of the jaws of this machine that makes small radio parts



SANDBLAST SUCTION TUBE. Formed from a rolled sheet of the synthetic resin, known as Resistoflex PVA, this tube has been in service three months. Rubber lasted a week at best

TRANSMISSION RINGS. The compound takes the place of rubber in rings that rotate against metal gears to power many operations





1927 First of the Vegas, with plywood monocoque fuselage. Wiley Post's "Winnie Mae" was a later Vega



1929 Sirius, designed by Lindbergh, was the first low-wing Lockheed. Orion and Altair types followed



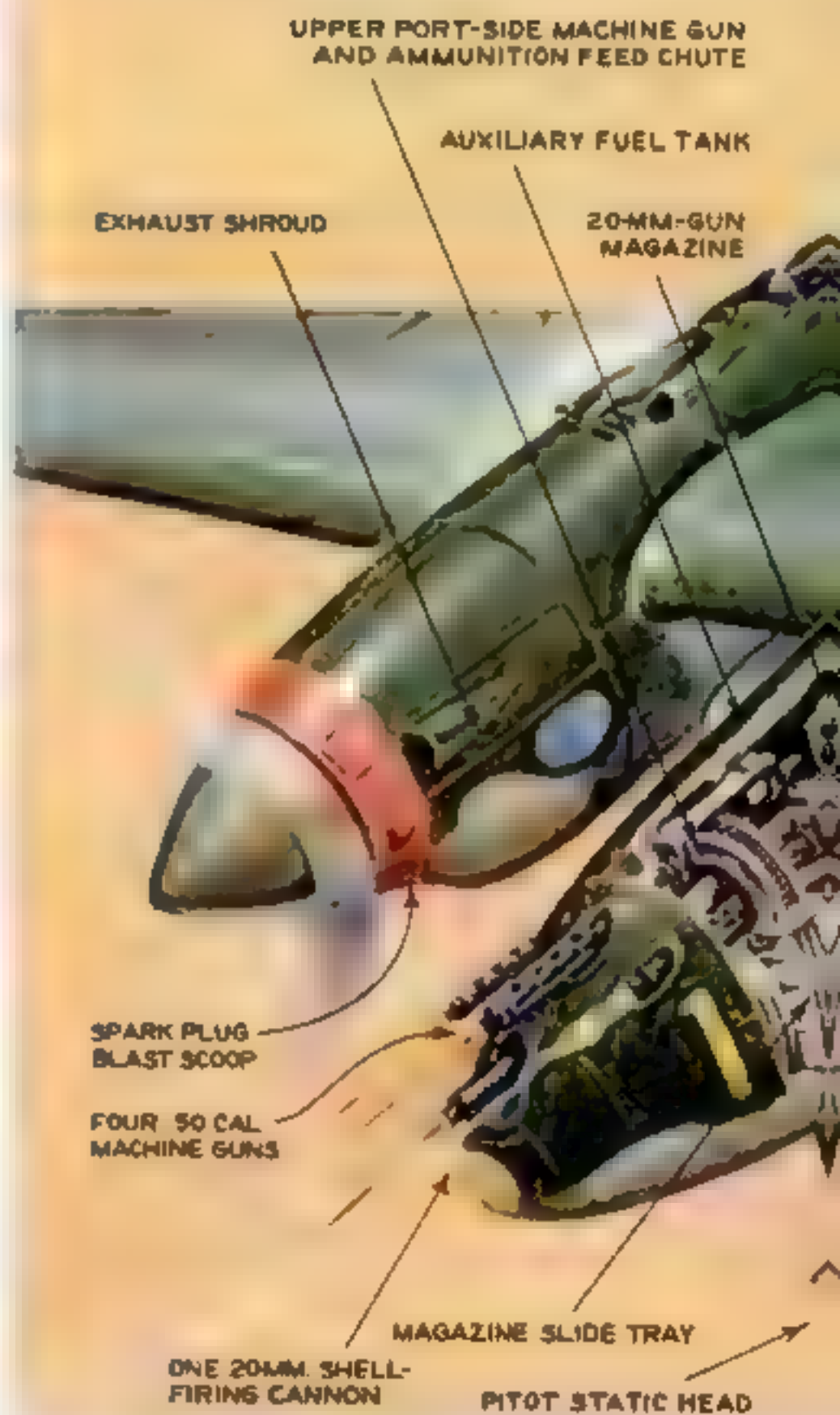
1937 Howard Hughes' globe-girdling Model 14 had twin-engine, twin-tail design foreshadowing the P-38



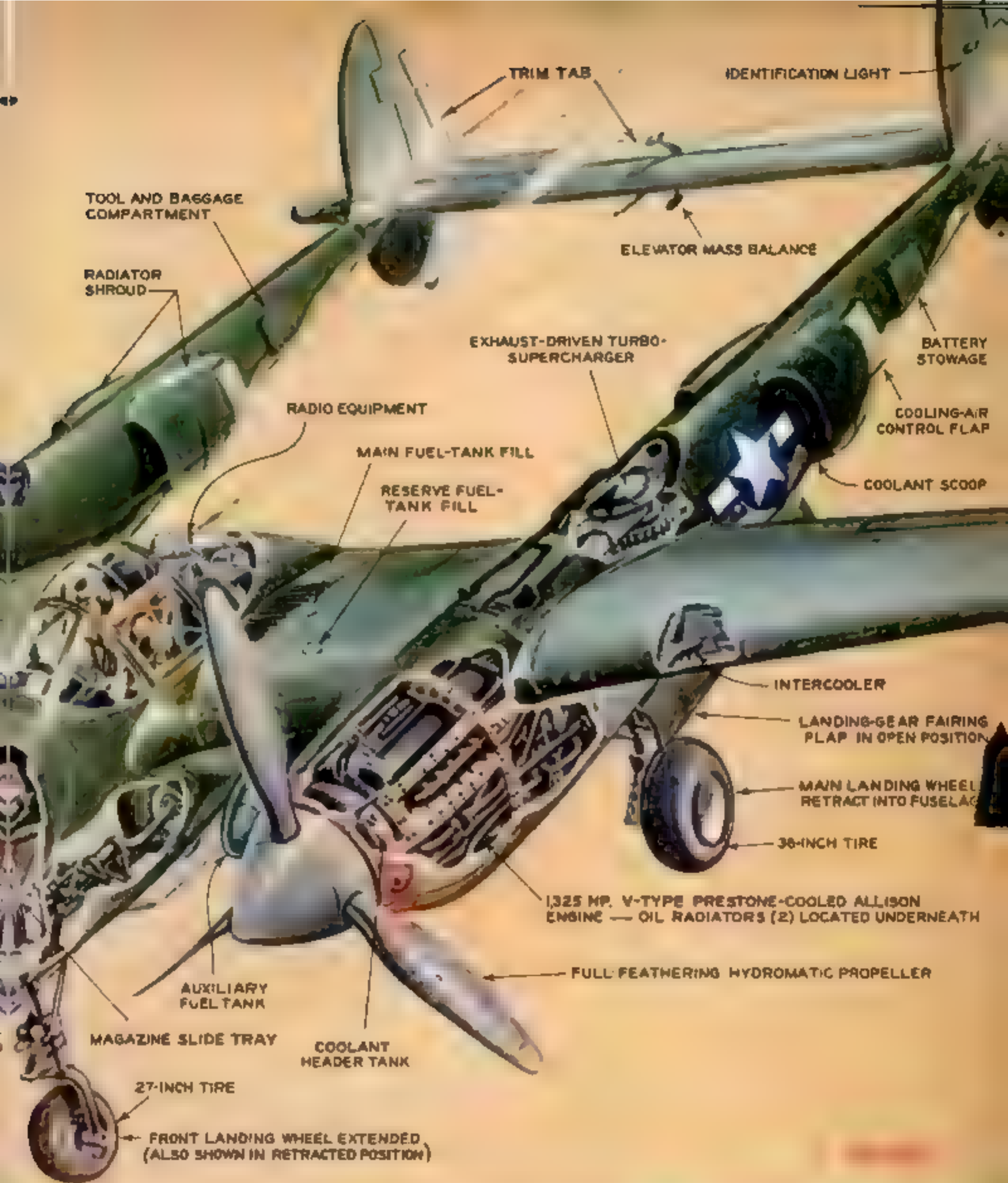
1939 Hudson bomber, military version of the 14, took Lockheed into warplane field. Ventura followed

Vega to Lightning..

Story of the P-38



BACK of the amazing and versatile performance of the P-38 Lockheed Lightning is a long line of famous planes. Although the first Lockheed (built by Allan and Malcolm *Loughead*) appeared in 1912, the story really goes back only to 1927, when the first of the famous "star" series the Vega—was born. With clean lines made possible by a patented plywood monocoque construction, the Vegas were among the fastest ships of their day. Wiley Post's



Winnie Mae was one of the early Vegas

Then came the *Sirius*, *Orion* and *Altair* low-wing monoplanes that figured in the record-breaking ocean flights and are associated with such great names as Lindbergh, Earhart, and Kingsford Smith. The *Orion* marked Lockheed's first use of retractable landing gear.

The Lightning's characteristic twin engines and twin tail assembly first appeared in the *Electra*, in 1934. The twin tail was

perfected in the Lockheed 14, test-flown in 1937. This ship, also incorporating Lockheed-Fowler flaps and exceptionally high wing loading, made history in 1938 with Howard Hughes' 91-hour 'round the world' flight.

Lockheed entered warplane construction by building modified 14's for the British as the Hudson bomber followed by the *Ventura*. The P-38's prototype was test flown secretly in 1939.

Taking the Jumps

QUARTERMASTER combat forces at Camp Lee, Va., have a brand-new jitter killer. It's a 275-foot, shallow trench of horrors through which trainees and officers must crawl at night. This twisting, slimy passage—suddenly alive with sounds and smells that rival the worst war can offer—accustoms men to unexpected happenings and prepares them for situations faced in actual battle.

Awakened in the middle of the night, you are told to don class X fatigues (old combat togs). You make as little noise as possible as you join a detachment that moves off swiftly and penetrates about a mile into the woods. Then you are ordered to start crawling. By that time you should know that you're about to be subjected to the new nerve-conditioning course.

You grope your way through a wooden funnel. Out of it you wriggle into sticky, ill-smelling mud. You move in silence, wondering what's coming next. Then, without warning, sounds of battle burst about you. You hear the rattle of machine guns, the scream of dive bombers, and one deafening explosion after another. These sounds come from loudspeakers and from booming cannon crackers tossed into huge oil drums hung overhead for that purpose.

Proceeding slowly, you feel your way onward. Water falls on you, simulating rain, and then, a few wriggles farther, you slide

head first into a pool of muck at the bottom of a shell crater. When you come out, sand blows in your face. You crawl under barbed wire, twist down a steep bank, and go forward in the cold dampness. Without warning, you are struck by a stench, and a star shell reveals what appears to be a body in an advanced stage of putrefaction. It's actually a dummy saturated with foul-smelling butyric acid. But looks and odor are real enough. The last lap of the course is a gas-filled chamber that compels you to put on your gas mask.

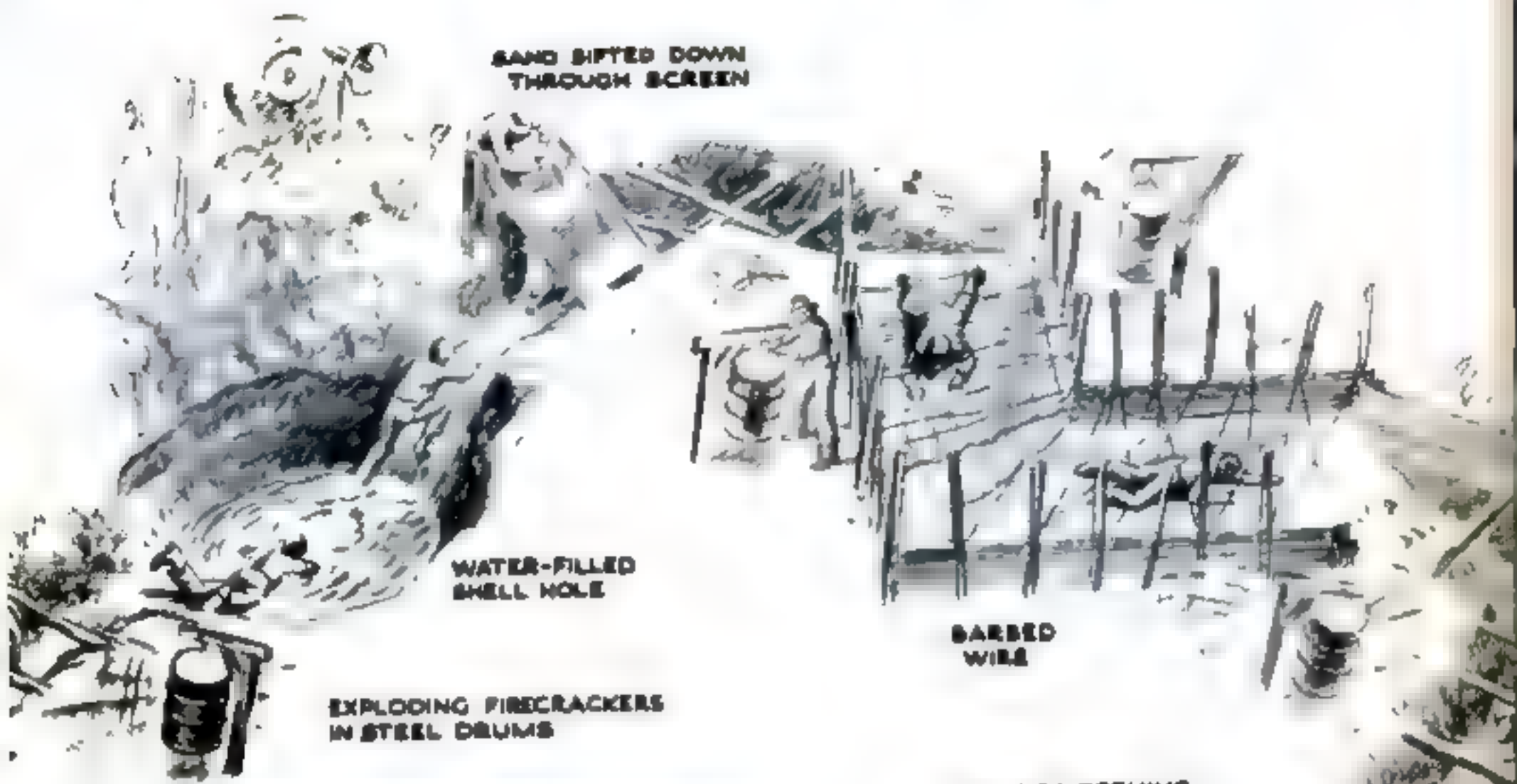
SOUND TRUCK REPRODUCES
BATTLE NOISES

WATER
DRIPPING
TO SIMULATE
RAIN

50-INCH CLEARANCE
UNDER LOG-ROOFED MAZE

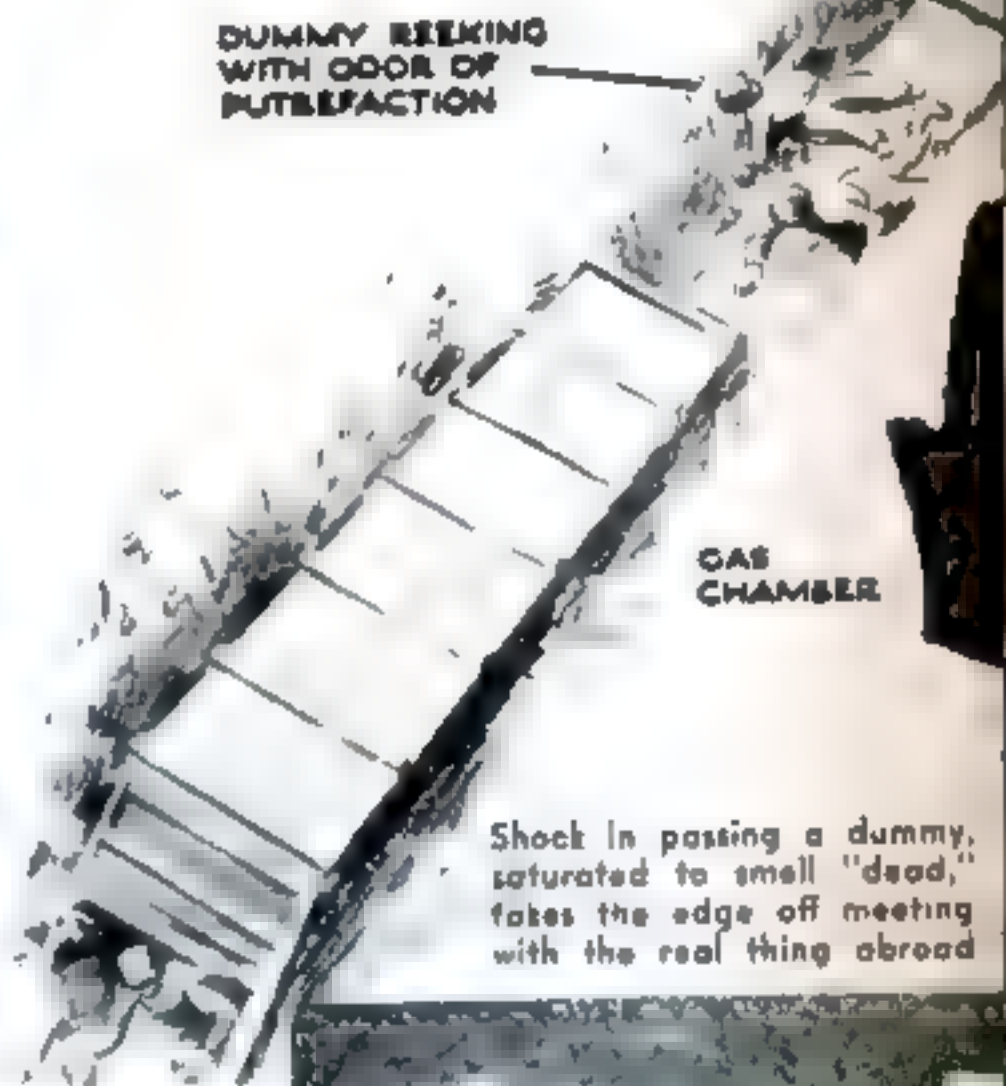
START

Out of Army Nerves



Sliding headlong into a mudhole is but one harassing incident in the Camp Lee trench of horrors sketched here by the artist. Coming out, a soldier is met by a burst of simulated machine-gun fire. It is part of Army training to accustom men to real battle conditions

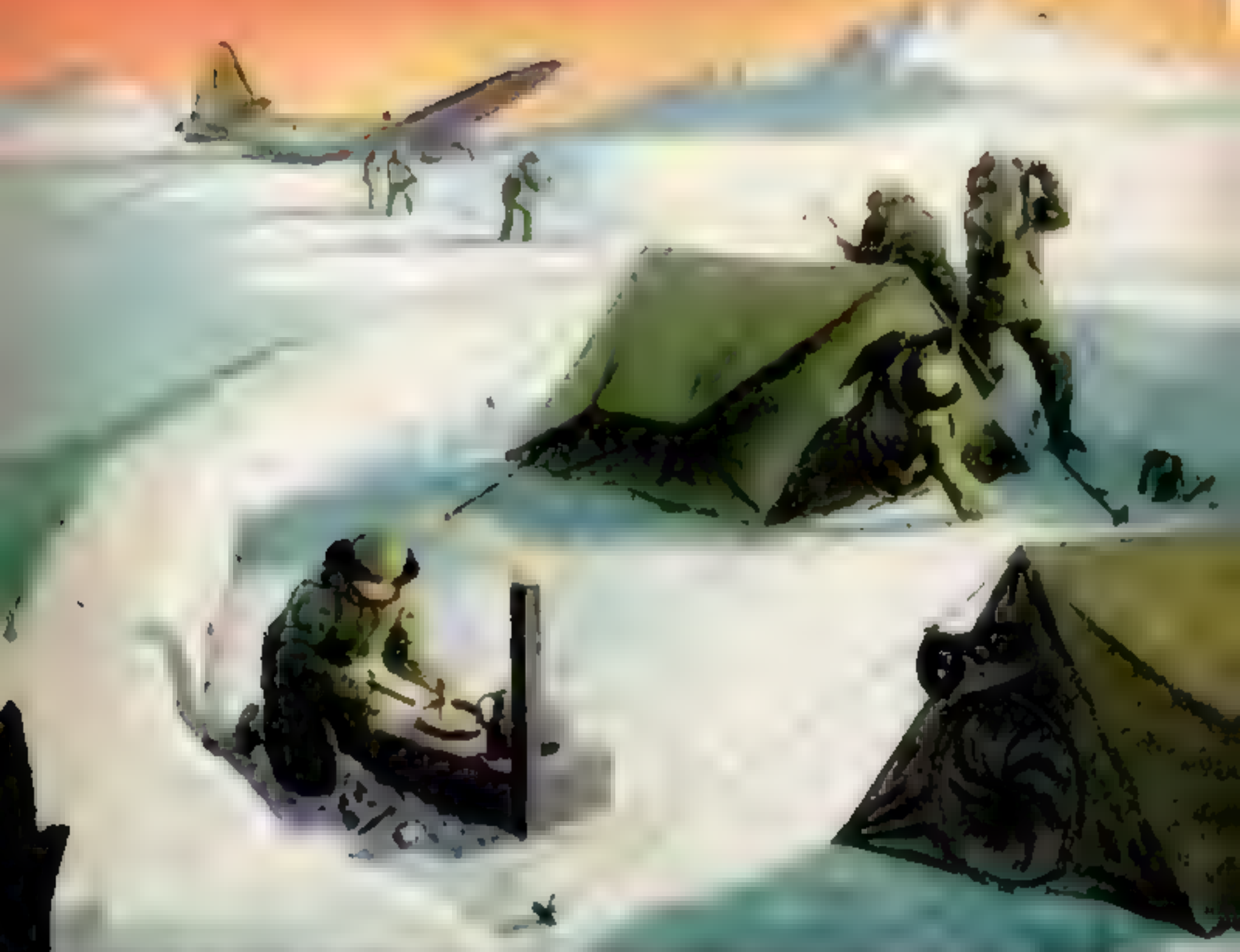
FINISH



Shock in passing a dummy, saturated to smell "dead," takes the edge off meeting with the real thing abroad



Aid from the Sky for Marooned Arctic Flyers



TO aid flyers forced down on the wastelands of the Arctic, the Army Air Forces have designed an Emergency Sustenance Kit, Type E-12, that can be dropped from a plane to sustain the marooned men until they can be rescued. That part of the kit containing rations and implements (at upper right) is floated to earth on a parachute. The rest of the kit, containing clothing for two men, is dropped free-fall. A pouffe, blue on one side and yellow on the other, and carried in every Army plane, is folded in different patterns to signal needs.

EQUIPMENT DROPPED FREE-FALL



(1) Multiple-roll sleeping bag and (2) 40-oz. ration container. The bag is protected by a cushioned pack.

(3) Two pairs of white socks and (4) two pairs of white shoes. The shoes are made of a special material that is resistant to cold.

(5) A pair of yellow trousers and (6) a pair of yellow and blue flight suit. The suit is made of a special material that is resistant to cold.

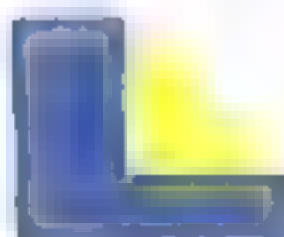
(7) A pair of yellow and blue flight suit. The suit is made of a special material that is resistant to cold.

EQUIPMENT DROPPED BY PARACHUTE

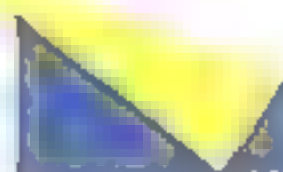
1. Container for type (a) (ration) tin
2. Can of gasoline
3. Ice ax
4. Shovel
5. Container for type (b) (ration) tin
6. Container for type (c) (ration) tin
7. Matting with ice scrapers attached
8. Air mattress
9. Tent
10. Signal pistol, type (a) of tin, but carried in all Army planes
11. Snow goggles
12. Tent (shown on left)



HOW THE TWO-COLORED PAULIN IS FOLDED TO SEND MESSAGES



Gas and oil are needed. Plane is flyable.



We are in need of tools. Plane is flyable.



Do not attempt to make a landing.



Indicate direction of civilization



Should we await rescue plane?



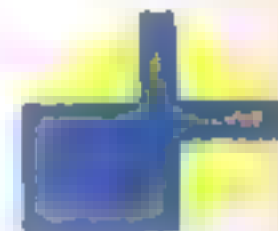
Left plane walking in this direction



O. K. to land in arrow's direction



We require warm clothing.



We are in need of first-aid supplies.



We are in need of medical attention.



We require atabrine or quinine.





TOW FOR LONG TOM. A high-speed prime mover for our 155-mm. rifle is provided by the new M-4 tractor, which not only drags the big gun many times faster than the tractor formerly employed but

also carries the gun crew and some ammunition. The six-bogie-suspension chassis is the same as that used on the M-4 medium tank and M-7 and M-10 tank destroyers. The tractor mounts a .50 AA machine gun.

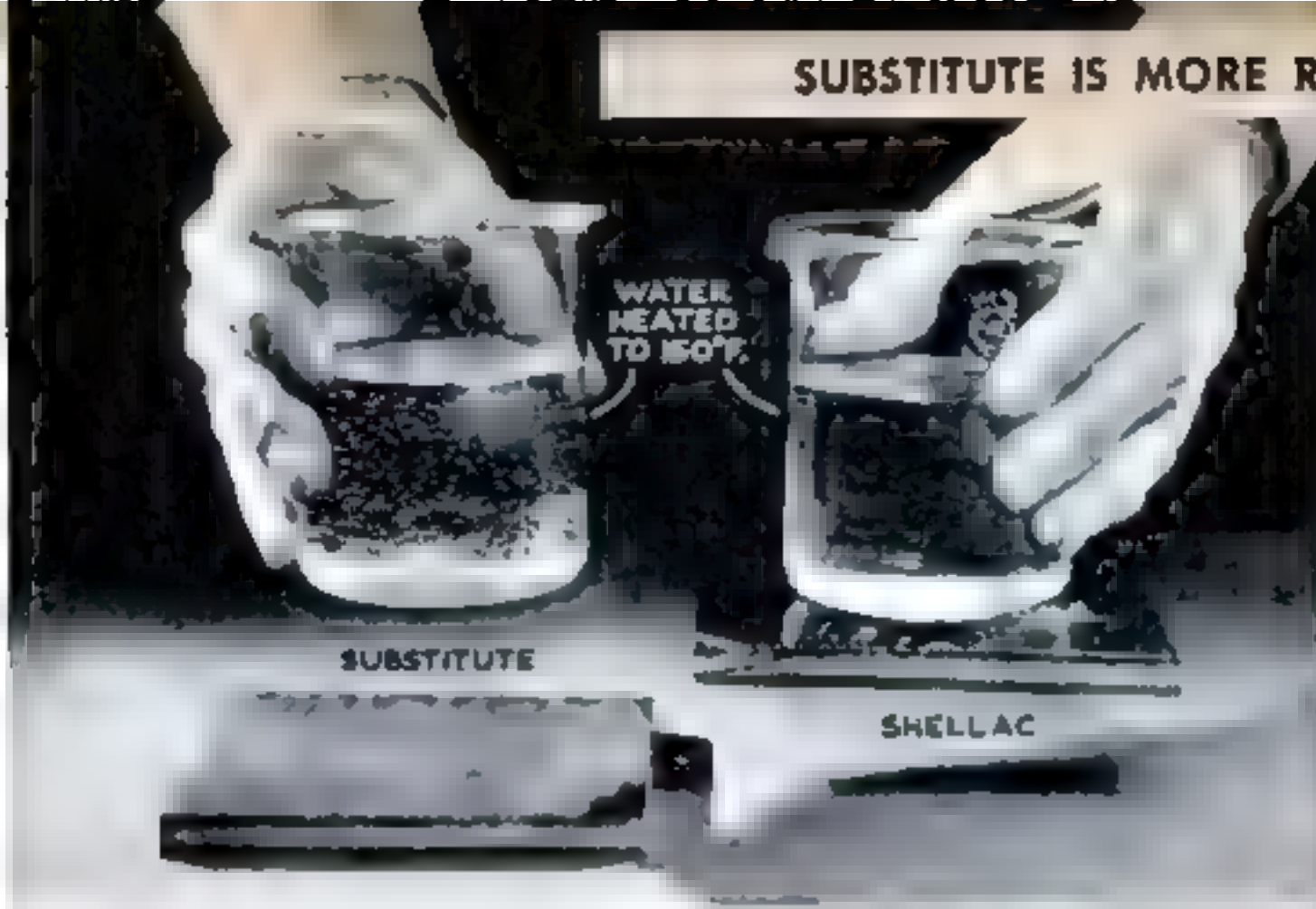
TAMPALA, a vegetable enjoyed for centuries in India and China has been introduced to America by the W. Atlee Burpee Co., of Philadelphia. The plant, which is shown below, grows to about two feet in height and produces tender leaves that can be cut throughout the summer. Cooked and served like spinach, the new "greens" are said to be better than spinach in some important respects.



OXYGEN CYLINDERS that will not explode when struck by machine-gun bullets have removed one of the dangers facing high-altitude flyers. A second weld at the seams causes the compressed-gas containers to tear when punctured, as illustrated.



SUBSTITUTE IS MORE RESISTANT TO HEAT



Beakers of water heated to 150 degrees are set on two wood blocks—one coated with shellac and the other with the new substitute. In a half hour of this "hot-dish" test, the shellac sticks fast to the beaker, the substitute remains hard

SUBSTITUTE RIVALS SHELLAC

MEETING a scarcity of shellac, which is normally made from imported materials, a substitute has been developed from a waste product of cornstarch and is already being used on planes, ships, and tanks, and in hundreds of special war applications. It bids fair to become a real competitor of shellac in peacetime use at the end of the war, proving in tests, it is said, to be harder than genuine shellac and more resistant to heat and to moisture.

The basic substance in the new product, called Zinlac, is zein, formerly a cheap cattle feed derived in the making of cornstarch. William Zinsser & Co., of New York City, experimenting with it to develop a civilian substitute for priority shellac, traced a deleterious inclination to jell to intermittent agitation caused in shipping and finally conquered this chemically.

So successful were tests that the shellac substitute itself was put on the war priority list. Along with competing with shellac, it has been found to have many new applications.

SURFACE IS HARDER

In the "print" test, a square of canvas is laid on each panel and a uniform weight is applied. After 24 hours, the shellac shows an impression and the substitute none

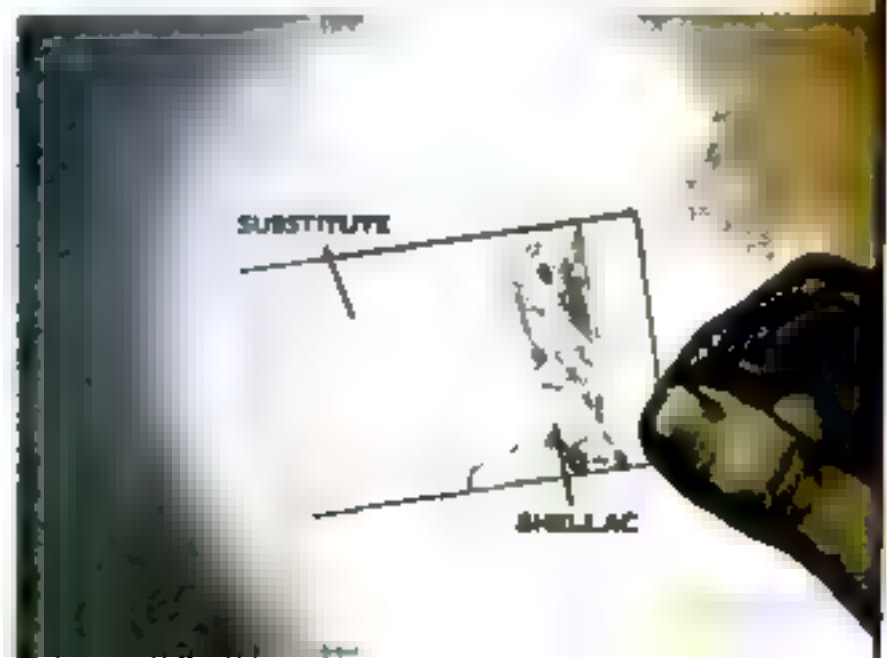


CLEARER, COLORLESS



A small quantity of the new zein shellac substitute poured on a glass slide can be compared with shellac and other substitutes

The zein substitute dries absolutely hard in four hours and forms a perfectly smooth, clear, colorless film that won't wash off





23rd Fighter Group



31st Fighter Squadron



48th Fighter Squadron



71st Fighter Squadron

DISNEY CARTOONS SPUR COMBAT FLYERS

TRULY echoing the fighting spirit of our young Air Forces, the colorful Disney cartoon designs that identify squadrons and groups hide a grim message of hate under a deceptively frivolous appearance.

The first identifying insignia for an aircraft squadron, a "Hat in the Ring" motif symbolizing Uncle Sam's joining the Allies used by Eddie Rickenbacker's 8th Squadron in World War I, was more studiously patriotic than today's flippant but effective markings. Now high-ranking favorites judging from requests to the Disney studios, are Donald Duck, Dumbo, Thumper, and other stock cartoon characters, although the studio artists will create a design around any figure, real or fictional.

The insignia, two to three feet high, are painted with stencils on both sides of planes near the cockpit, and crew members often wear an embroidered replica of the symbol on the left pocket of their flight jackets.



307th Fighter Squadron



308th Fighter Squadron



106th Observation Squadron



121st Observation Squadron



9th Photographic Squadron



39th Air Base Group,
Savannah, Ga.



503rd Parachute Battalion



First Army Support Command



21st Bombardment Squadron



27th Bombardment Squadron



41st Bombardment Squadron



58th Bombardment Squadron



75th Bombardment Squadron



77th Bombardment Squadron



308th Bombardment Squadron



342nd Bombardment Squadron



401st Bombardment Group



406th Bombardment Squadron



451st Bombardment Squadron



Air Corps Training Detachment, Oklahoma City, Okla.



Advanced Students, Ellington Field, Tex.



92nd School Squadron, Craig Field, Ala.



Advanced Flying School, Luke Field, Ariz.



468th School Squadron, Randolph Field, Tex.

Light Gauges Airport Ceiling

ACCURATE day or night measurement of cloud ceilings, so important at airports where exact information is required by pilots, is made possible by triangulation with a new photoelectric development. A pulsating beam from a high-pressure mercury arc lamp is directed straight overhead, while a tuned pickup known as a "ceilometer" receives the reflection from the point where the beam encounters cloud formations or

other ceiling densities. Mechanism between the "ceilometer" and a recorder translates the angle of reflection into cloud distance. This new device, which has measured clouds at elevations up to 20,000 feet, brings to daytime calculations the high degree of accuracy that had been attained previously only at night with the use of a vertical searchlight beam. It was developed by the U. S. Weather Bureau with the aid of General Electric lighting engineers.

RECORDER. Dense clouds and rain, snow, and haze ceilings are measured instantly by this device that picks up the reflection from a beam of light

PROJECTOR. Operated by 110-volt A.C., a tiny mercury arc lamp sends up its 120-cycle beam. It is cooled by high-pressure air blasts





So clear is this section of a strip recorded at 500 feet that even the "A" tag on the windshield is visible

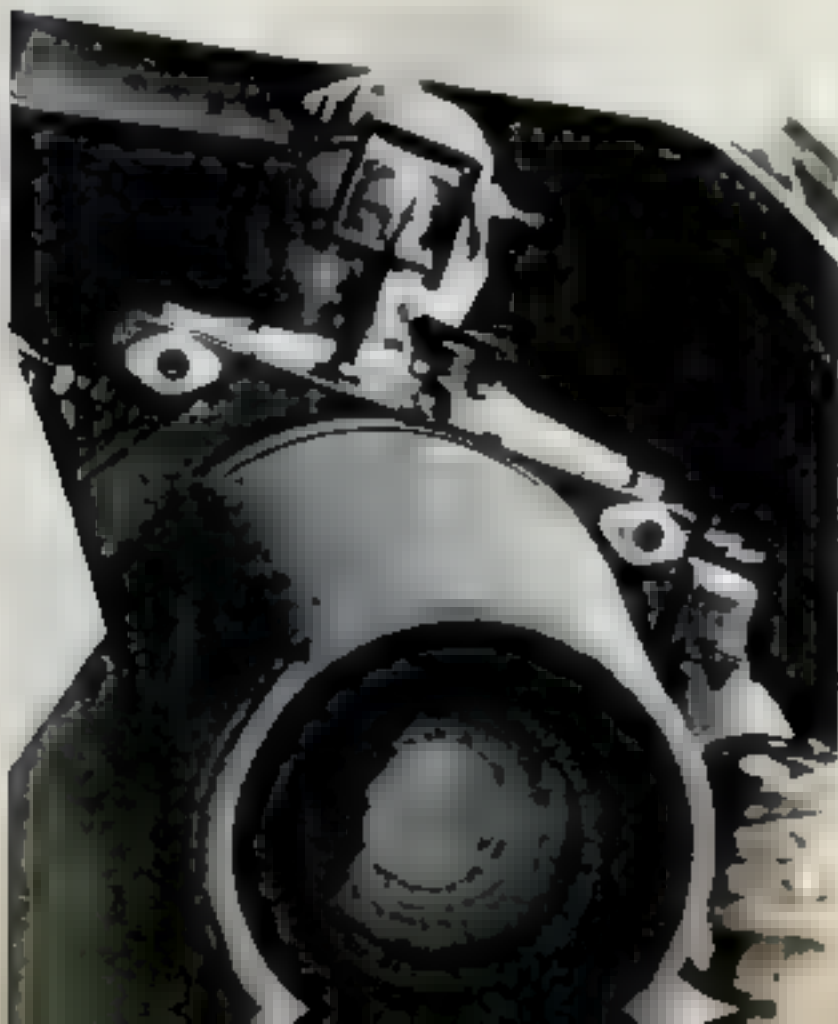
Photos at 300 Miles an Hour

ONE of the most important aerial advances of the war is strip photography—a big step forward from the late war piecing together of a series of reconnaissance shots. The Sonne camera, designed to perform this feat, is much like other aerial cameras in appearance, but it oper-

ates without a shutter. Film, synchronized with the speed of the plane, moves past the lens as it records the terrain. Clear pictures are possible from a plane racing at 300 miles an hour and at altitudes from 100 feet above the ground—far below the effective level of ack-ack—to 7½ miles.

Jutting from a bomber window, the strip camera looks formidable. Film moves behind an open slit back of the lens. Below, printing from a strip negative. Processing the film takes 15 minutes and 20,000 prints can be turned out in 24 hours.

(Opposite page) Photos by S. Army A. Forces



Fangs for the LIBERATOR

A JAPANESE manual on aircraft recognition, recently captured, lists the B-24 Consolidated Liberator as a "four-engined fighter." Considering the number of Zeros that these far-ranging bombers have knocked down in the last few months, this classification is not so far from the truth. The new deadliness is largely due to the elimination of the last weak link in the Liberator's armor of fire, the nose armament. Consolidated engineers have modified the nose and installed the newly designed Emerson twin .50 caliber turret in place of the free, swivel-mounted guns formerly used. Placed far out, the new turret can cover an arc of over 200 degrees in the horizontal plane and over 90 degrees in the vertical.

The new Liberator has the greatest variety of armament emplacement of any bomber in service today. Besides the twin .50 caliber Emerson nose-mounted turret, it carries a twin unit built by Martin on top, a two-gun Sperry ball turret (the same as on the Flying Fortress) in the belly, and Consolidated's own twin .50 turret in the tail. These are augmented by two single pedestal-mounted .50's in the waist.

While it is true that other heavy bombers carry a greater number of .50 guns than the Liberator, this is a decided asset to the B-24. If, through the proper emplacement of fewer guns, it can completely cover itself with a protective curtain of fire, it can invest the weight thus saved in more rounds of defensive ammunition, or more bombs to drop on the enemy.

At Consolidated's Fort Worth plant, the B-24's new nose turret gets final pre-delivery wrapping. Out-front position gives this emplacement the widest sweep of any powered turret in use. The guns can be depressed below horizon level.





BLIND SPOTS are reduced to a minimum in the new Liberator. While the wing and engines still keep part of the fire orbit open, the inboard part containing the engines and tanks is now covered by the nose guns from the front and by the top and bottom turrets from the rear. In the Pacific, it took the Japs a long time to find out about the nose turret, so few of their fighters came back to make reports after tackling B-24's



Automatic constant-speed propellers with three and four blades come off the production line. A pilot can change the blade angle in a matter of seconds.

Making the Hollow 'Prop'

MAINTENANCE and installation of constant-speed propellers have been simplified by unit construction that is now being done with production-line methods. These propellers, used widely by the Army Air Forces, have a new-type hollow steel blade with a longitudinal rib and are designed to hold engine speeds constant and meet variations in load requirements by automatic changes in the angle of the blades. So sensitive and fast is the governor coupled in the assembly that the pitch can be changed several degrees a second to maintain speed even during extreme pursuit maneuvers.

Operations in the manufacture of an Aero-prop blade are shown in the accompanying photos taken on the production line of the Aero-products Division of General Motors Corp. at Dayton, Ohio.



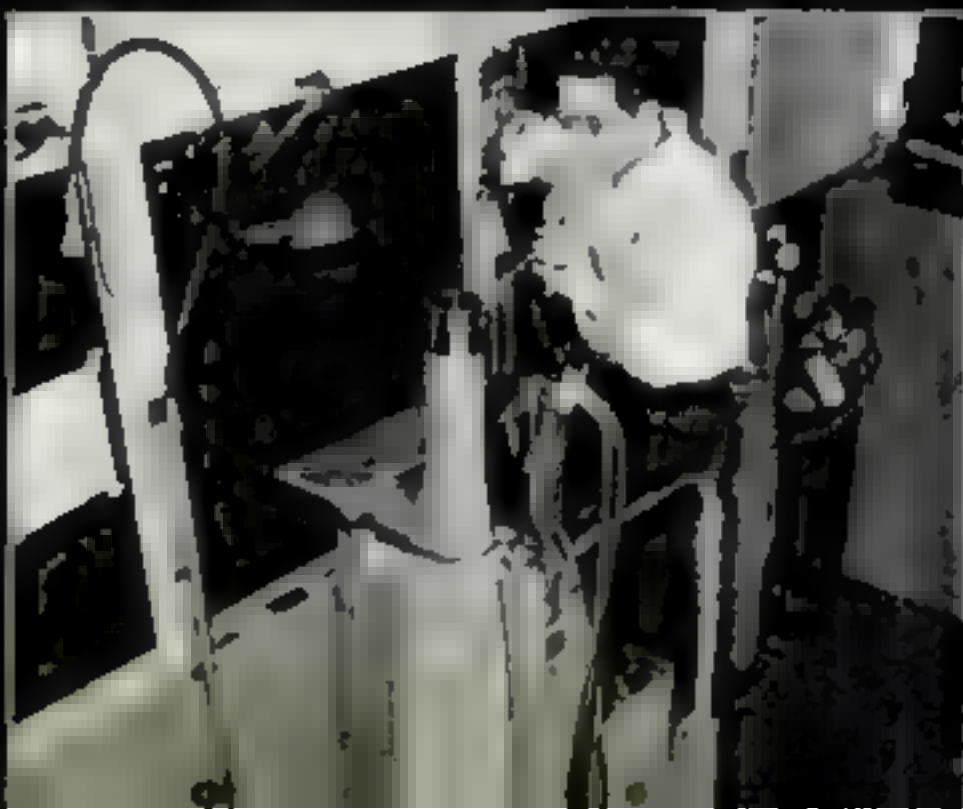
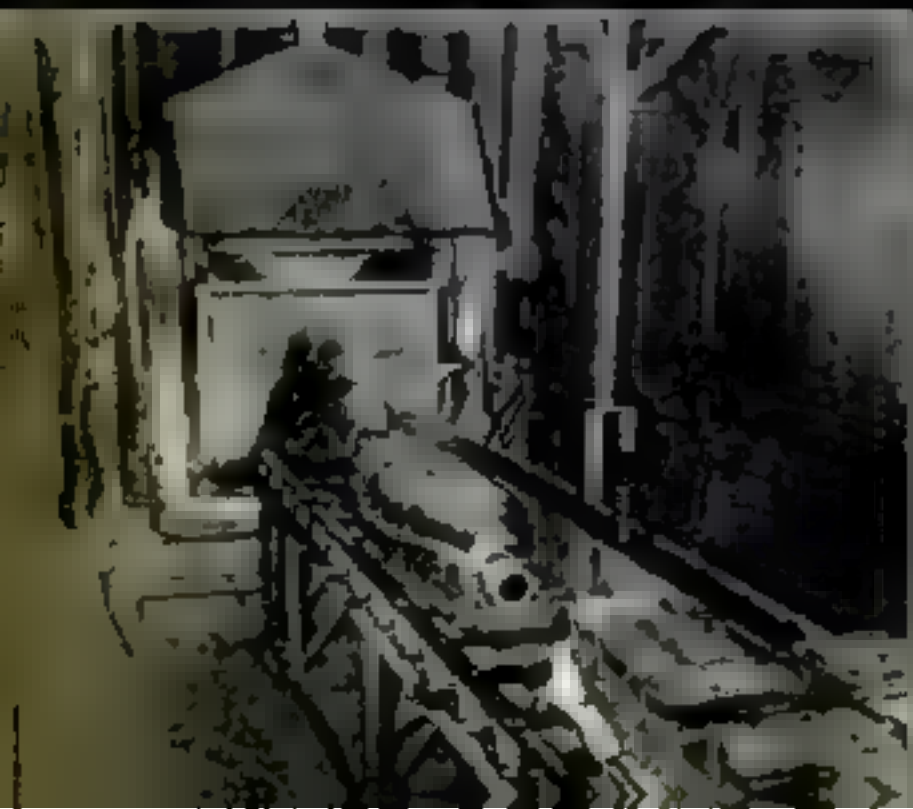
1 Guided by a master form and follower (on top of the upright), this shaper cuts extra width and weight from the original blade forging.



2 When specifications have been met, the camber, or pucking side of the blade, is fitted to the shaped forging to form the completed hollow unit.

3 Assembled cambers and forgings held together in special fixtures are put into the bracing furnace for bending at 2,000 degrees F.

4 One of the last operations in making a blade is the pouring of melted lead into the balance cup in the base to give the propeller accurate balance.



THE GUN is similar in size, weight, and appearance to the .50 caliber Browning machine gun, and is issued in both the water-cooled and the air-cooled types

AMMUNITION consists of plastic pellets $\frac{3}{8}$ of an inch in diameter. Used in place of real bullets, they save \$180 every minute of operation



BATTLE NOISES HARDEN GUNNER'S NERVES

A .50 CALIBER Browning machine-gun mock-up that shoots plastic bullets and trains a student in marksmanship while conditioning him to the distracting sounds of battle has been developed for ground and aerial gunners. As the student manipulates the gun in a 50-foot indoor range and tries to hit moving models of planes, tanks, and men, two loudspeakers directly behind him blast out the ear-splitting noises of combat that jangle a gunner's nerves.

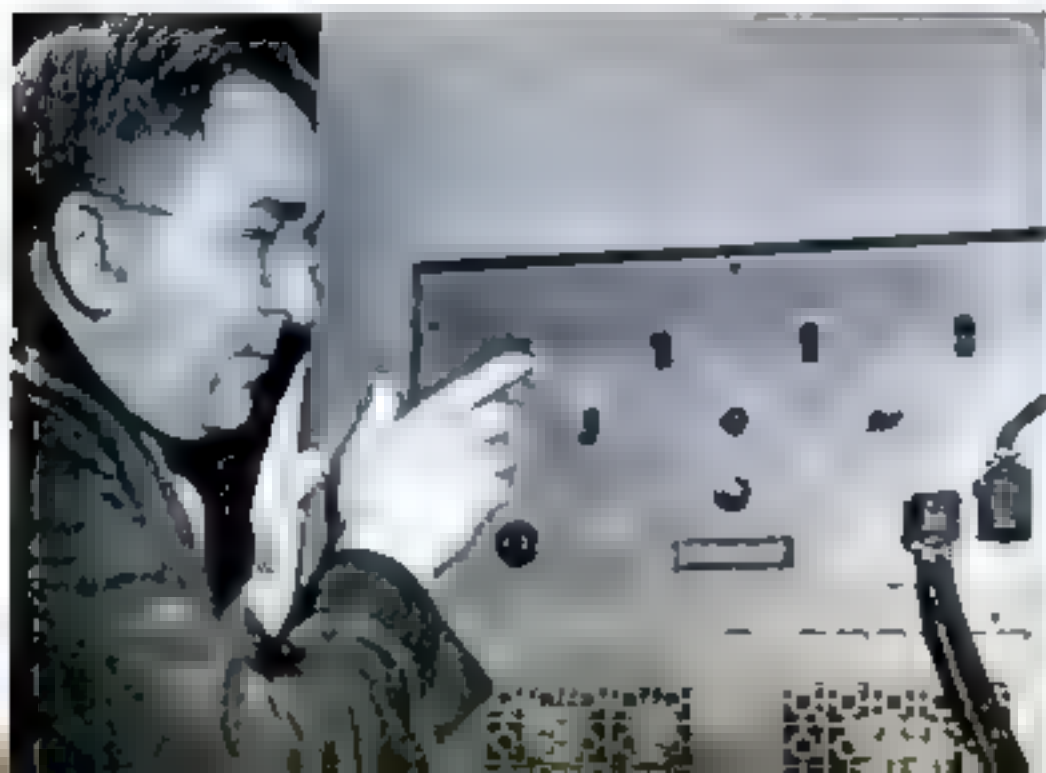
Using compressed air for propulsion, the

mock-up, known as the M-9 Trainer, throws as many as 300 pellets a minute. Recoil is simulated by an electromagnetic device.

To train a student in daylight tracer-control firing, white pellets are used against a dark backdrop. For night tracer-control firing, the range is darkened and the pellets and target models are coated with luminescent paint. Developed by the Edison General Electric Appliance Co., Chicago, the trainer is on display at the Chrysler-Army Ordnance Show in New York.

CONTROL BOARD. Top switches, left to right, operate fire, recoil, gun sound, and battle sound

BATTLE SOUNDS are picked up from phonograph and amplified by loudspeakers





Stripped Spit

HIT-AND-RUN photo reconnaissance over Germany and the occupied countries is one of the newest uses for the famed Supermarine Spitfire. Stripped of its armament and other surplus weight, this fast RAF plane dashes in and comes back with pictures of Nazi defenses

Play Ball!

ALL the thrills of real baseball are packed into this game, which may be played by two or more contestants. Flipping a lever, one player pitches the ball toward home plate. An opposing player, by twirling the batter, who swings on a pivot, then tries to knock the ball out of the park. Details on the rules, and on the construction of the game, can be found in the Home and Workshop section



THIS IS THE LAST WORD IN FIELD UNIFORMS



POCKETS. Made of a water and wind-resistant sateen fabric, the new jacket has four large pockets with overlapping flaps that keep the buttons from becoming snagged



HOOD. The jacket can be easily converted into a parka by means of a hood that fastens on the shoulder-strap buttons and fits over the helmet to protect ears, chin, and mouth



BOOTS are made of reversed cowhide. Although 10 inches high, with a two-buckle flap, they can be donned more quickly than old GI shoes and leggings



DRAWSTRING at waist holds jacket close to body, keeps out cold blasts of air. New fastenings hold cuffs snugly to wrists. Jacket lining is of poplin

Can GI Take It?

Brand-new Army clothing is worn to tatters in a proving ground where muddy fields, barbed wire, and brambles show up the physical fitness of our combat dress.

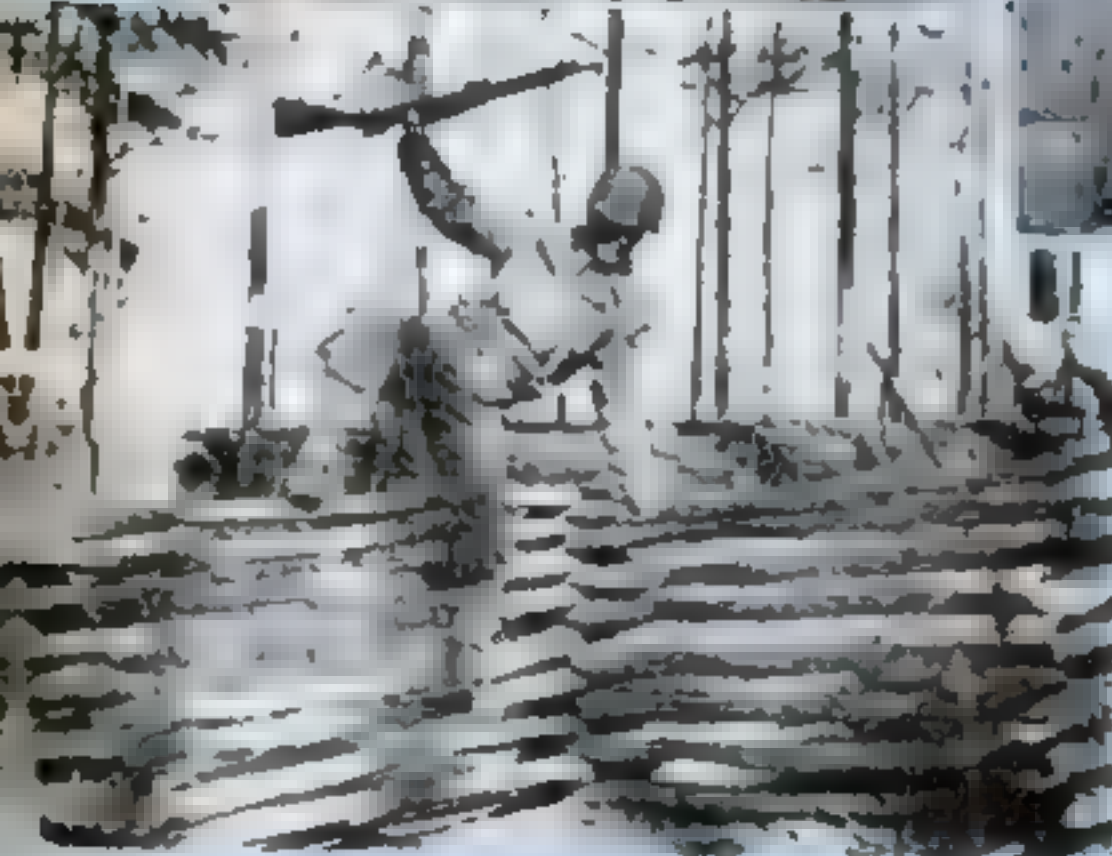
By JACK O'BRINE

Photographs by WILLIAM W. MORRIS

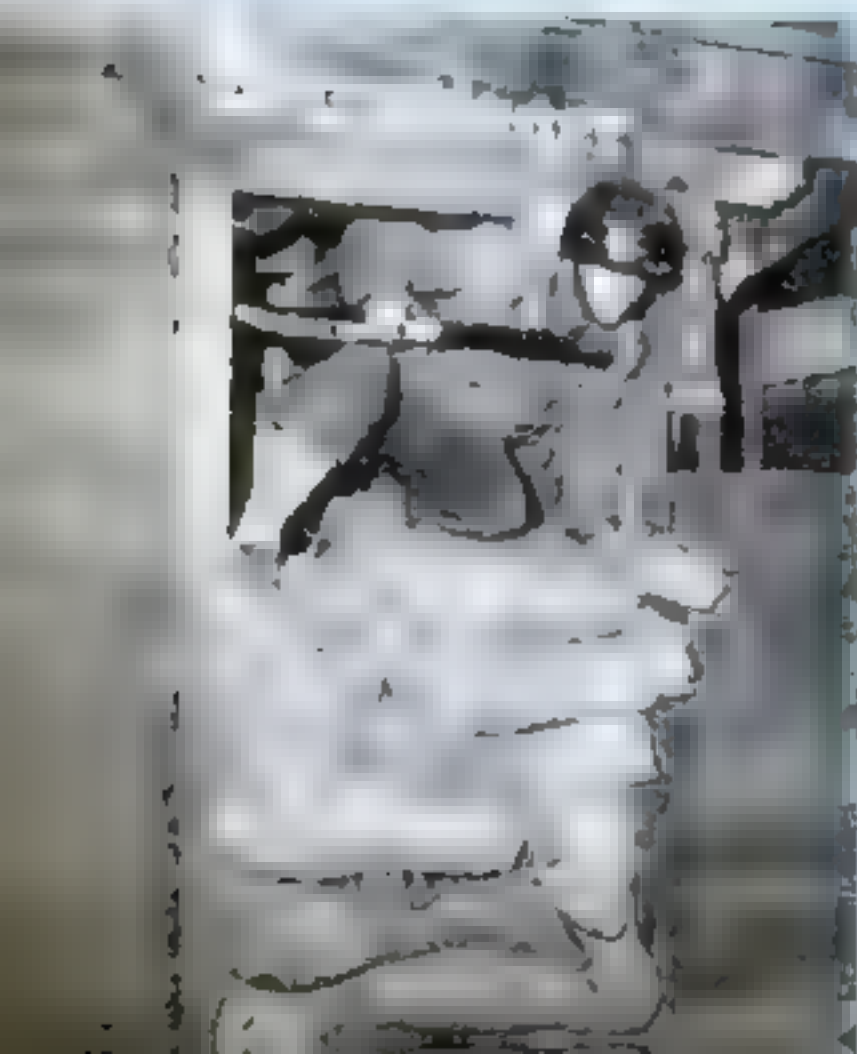
OUR Army travels on its stomach—also on its sides, back, elbows, knees, and feet. When a U. S. doughboy goes after the enemy, he goes after him in any posture that suits his purpose. If crawling's the thing, he crawls; if he must do "land backstrokes" to get under barbed-wire entanglements, he backstrokes; if it takes hiking to reach an objective, he hikes. In all, it's a supreme test for combat togs, which, from skin out, must be superlative to satisfy the needs of the world's hardest-hitting soldier.

Shooting for that quality in American

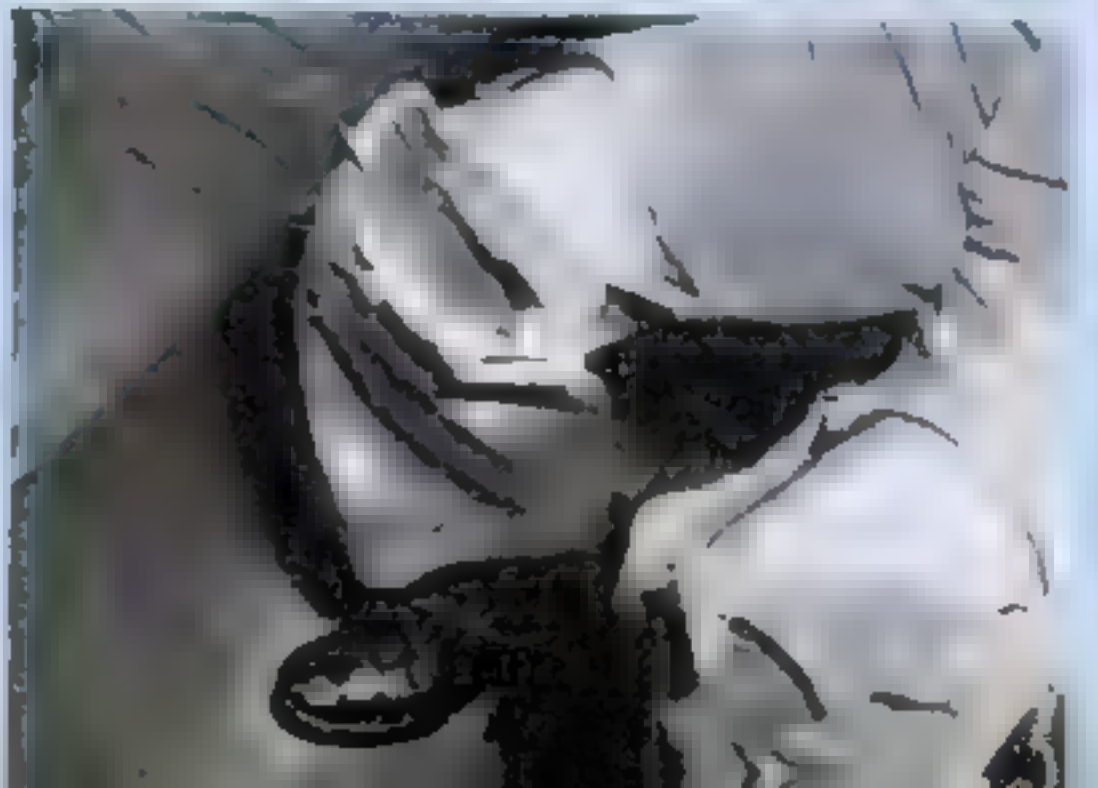
FOLLOWING IS THE STORY OF THE UNIQUE TESTS THAT HAVE BEEN USED TO IMPROVE ARMY DRESS

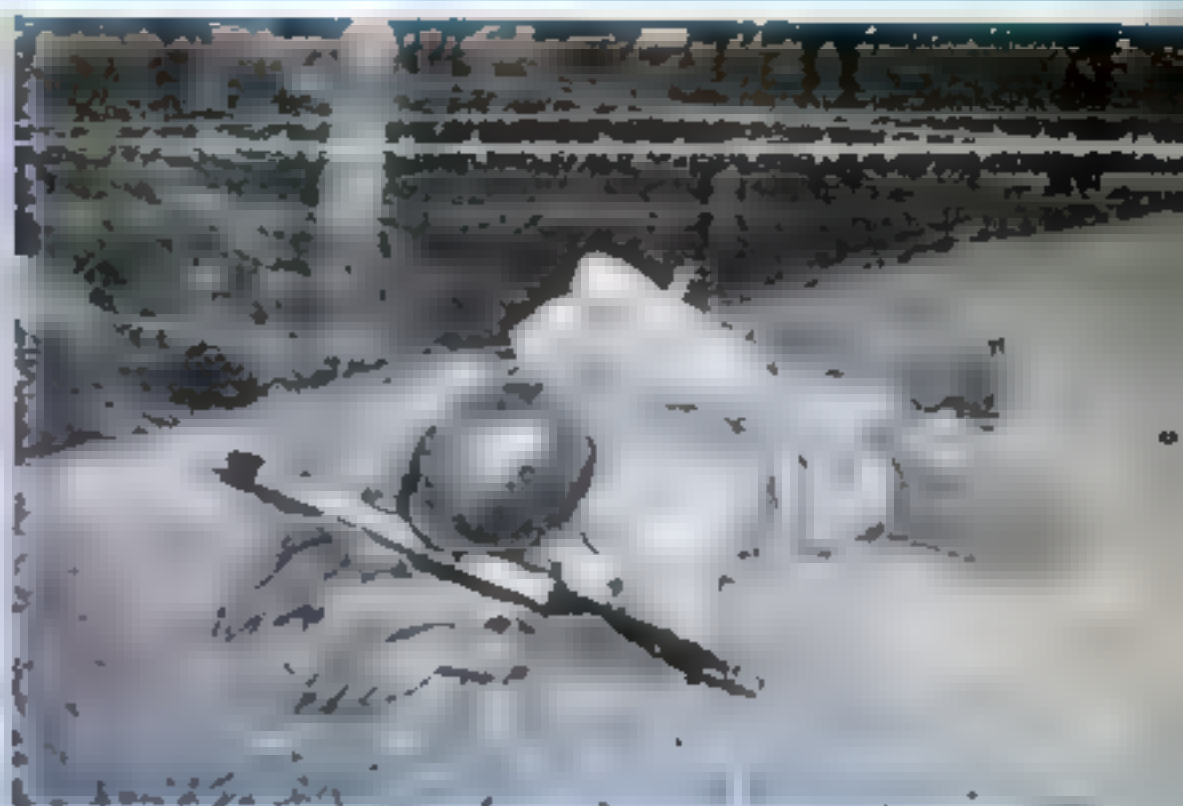


THE CROTCH. To test this part of the trousers soldiers scale a high wall by stepping on seats purposely placed at wide intervals so as to strain the seam and fabric. Often two men going over the course together will wear trousers submitted by two different manufacturers. Another good seam-tugger is to have a soldier either vault or hurdle a three foot fence. Still another test which strains knees and thighs as well is to load down a man with a full field pack and have him crawl his way up a tree, then come sliding down as fast as he can. It is this sort of rough usage that soon causes a badly made crotch to look like that shown at upper left.



KNEES have their own rigorous tests, one of which is to have a soldier squeeze his way through a narrow opening bending his knees tightly and rubbing the stretched knee area against abrasive surfaces. In another test soldiers take a running slide into a foxhole. Below, hereing drill trousers after four battering trips around the test course.





THE JACKET undergoes its acid test when a soldier, carrying his rifle in the crooks of his arms as he might in actual battle, and hugging the ground to avoid being caught on low-hanging barbed wire, crawls on his belly over needle-pointed chipped granite. Other tests include sliding into concrete tank traps and down steep revetments of sand and slog. The tear and ripped arm seam shown at the left was the result of only one trip around the course

fighting apparel, the Quartermaster Board Camp Lee, Va., has hit on one of the most curious and effective enterprises of World War II. It turns new battle dress to rags before your eyes on a testing course that has all the elements of wear and tear found on our far-flung battle fronts. Board technicians spot fabric and factory failures as they occur, and tabulate them to give a step-by-step record of a garment's deterioration. Frays, tears, tear-frays, holes, snags and split seams—all go into the chart. Out of it come improvements in style, material, and workmanship that give our fighters clothing built to withstand the rigors of battle.

With permission of the War Department, a writer and photographer of **POPULAR SCIENCE MONTHLY** recently visited Camp Lee's unique proving ground. It has been laid out by officers who have seen for themselves what our soldiers are up against in Europe and the Southwest Pacific. It sprawls beneath tall Virginia pines, in a weird obstacle-sprouting pattern of mud and muck, barbed wire, trenches, walls, revetments, wrecked buildings, and tank traps. Zigzagging around it and through it is a shoe-test track containing every kind of terrain that ever gnawed at GI shoes.

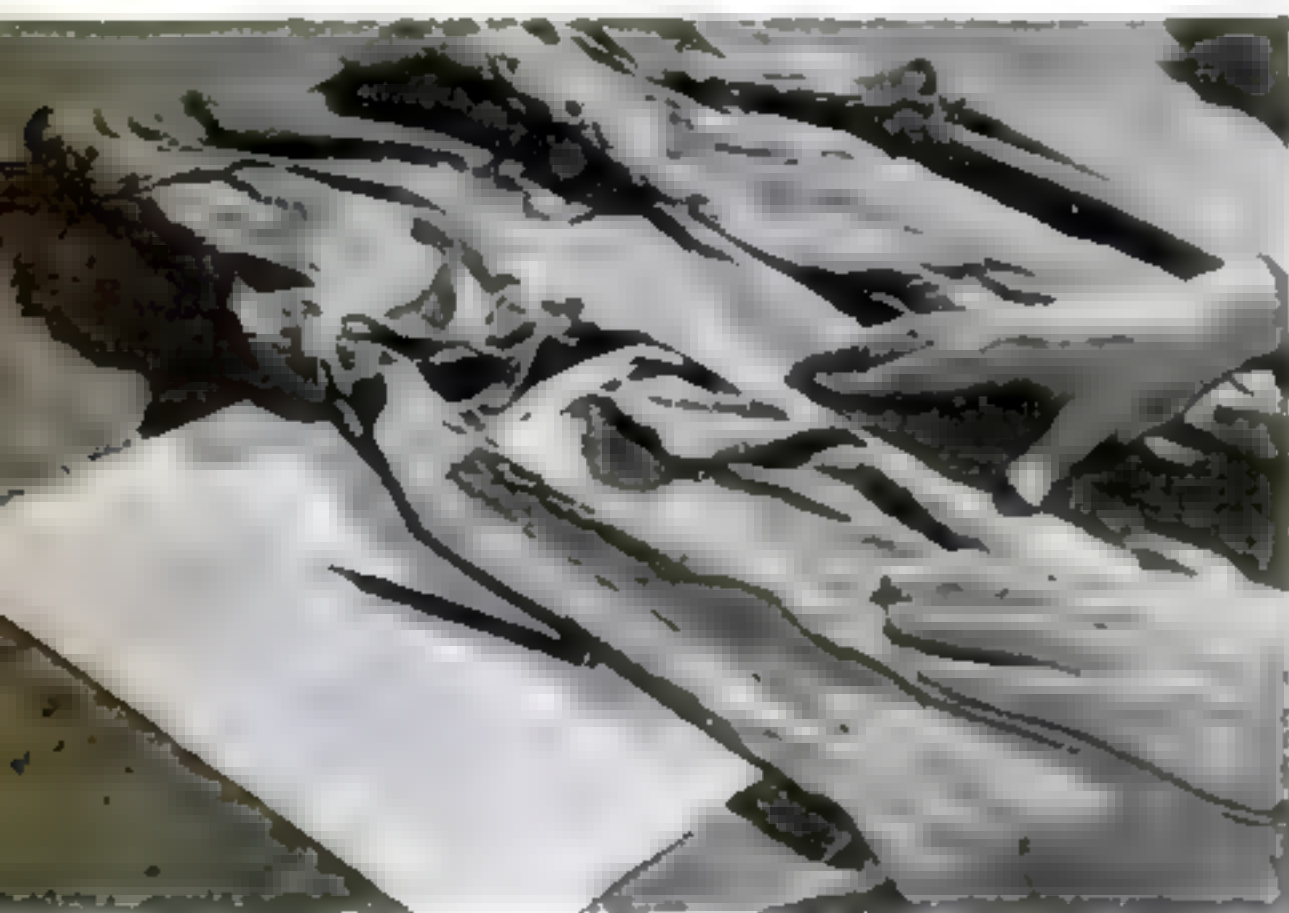
The scene is bustling with activity. It's alive with men in khaki and olive drab who carry on this odd war assignment. You see them, sometimes shoulder to shoulder, sometimes in single file, rushing barriers, scaling walls, bellying forward over chipped gran-

POCKETS and buttons are subjected to every type of wear and tear that they may have to undergo in actual use. One of the tests is to have a soldier crawl on his belly over the grime, nails and jagged splinters of the 'shelled enemy block-house below. Jacket, right, is ready to fall apart after four tests





SLEEVES get one of their most strenuous tests when men crawl through a sandy trench on their elbows and knees. Rips like that seen above have led to a reinforced stitching of the seams



THE TATTERS are carefully analyzed by technicians of the Quartermaster Board, who make a record of all failures resulting from inferior fabric or faulty workmanship. Experts also follow men around the course, observing the degree of wear as garments pass from one trial to another

weaves and shades gets a thorough testing. Some uniforms are soaked in synthetic perspiration (ammonium carbonate and water) to simulate conditions encountered in tropical battle grounds. But wearers of these take the olfactory abuse in stride.

With each detachment of soldiers is a "noncom" looking on intently. He jots down all major failures in clothing, noting the time of each, and the type of obstacle that caused it. His notations go back to the testing branch to be included in charts kept on every article of apparel undergoing observation. Then experts of the Quartermaster Board compile information thus obtained, and recommend changes that invariably improve combat gear.

Out of these recommendations has emerged the new and durable field dress of our overseas troops. Fabric is stronger, workmanship better, and style more in keeping with the exigencies of fighting men. And there has arrived that great boon to the doughboy—combat boots that put a timely end to his cumbersome leggings, fit his feet like soft gloves, and possess ruggedness sufficient to kick the daylights out of a reeling Axis.

ite, slithering through culverts, climbing slippery revetments, sliding into concrete tank traps. Some of them leap onto the course in spanking-new raiment. But soon it loses luster in the helter-skelter happenings that induce wear at a rate 10 times normal.

Even as you watch, crotches split, elbows burst through, buttons pop off, jagged tears appear, small frayed spots on knees become large ragged holes. Then you hear the tramp, tramp, tramp of soldiers marching over the sand, slag, gravel, and corduroy sections of the shoe-test course. You see feet kicking the life out of GI footgear. Some of the shoes were new only a few hours ago. Now they're mud-splattered, scuffed, and worn.

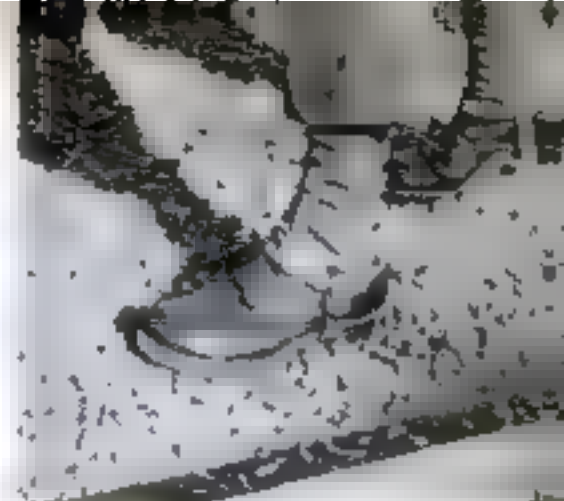
Within the shoes, socks also are subjected to the hard knocks of the course. And underneath uniforms, GI underwear of all



CORDUROY



SLAG



CHIPPED GRANITE

SHOES GET "FOREIGN-SOIL" TEST

Over a 2 000-foot track that has every type of terrain found in combat zones, including the beachheads of the Pacific (sand) and the lava-covered sections of Italy (slag), a pair of inferior shoes can be quickly tested to death. Other track parts test waterproofing and durability under severe flexing (corduroy).



SAND



MUD



WATER

GI BOOT IS A BIG STEP FORWARD FROM EARLY SHOE



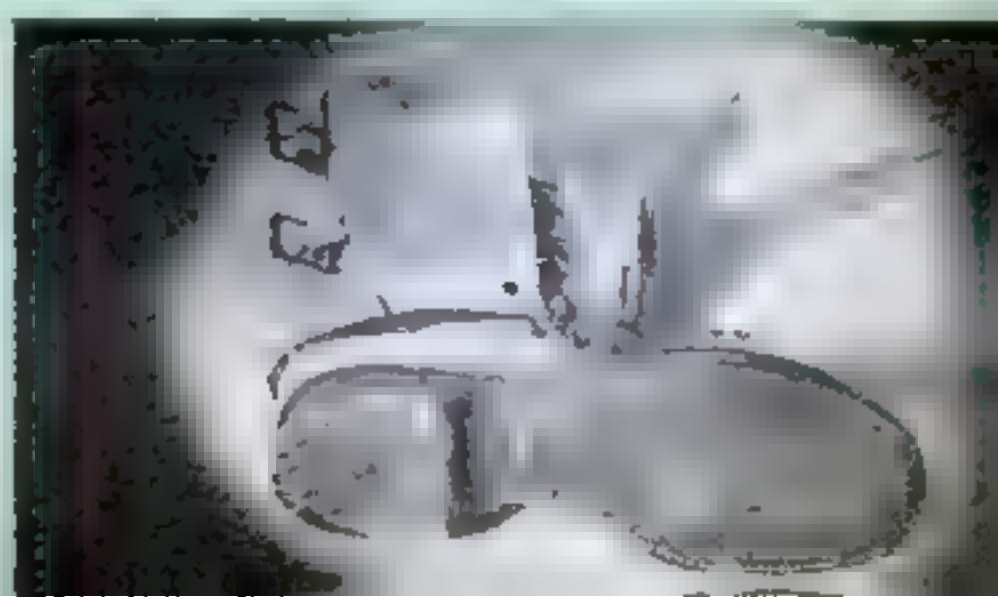
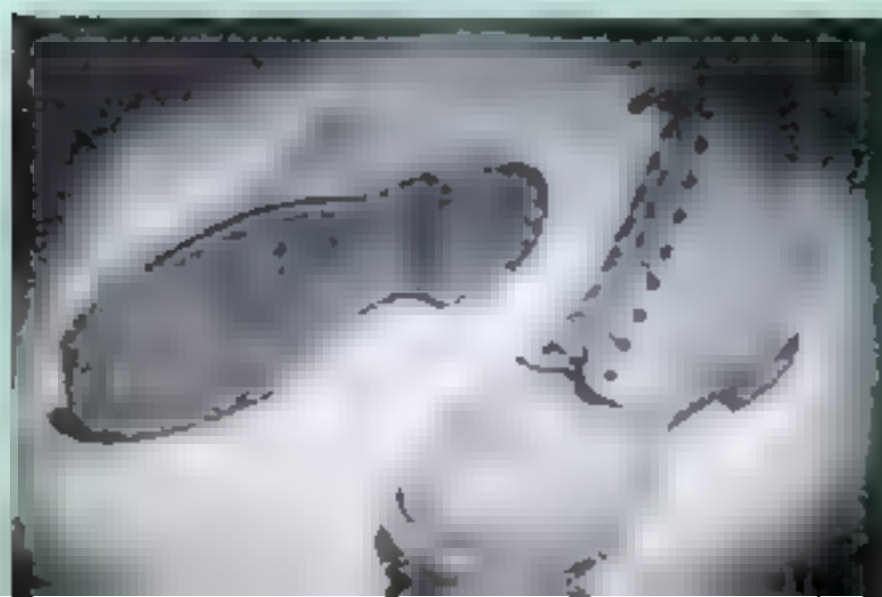
1 At the outset of the war, footgear issued to our soldiers consisted of a rather formal and not too comfortable looking pair of russet grain-out shoes.



2 Successor to the original GI shoe, which tests revealed had insufficient staying power, was a shoe with a much longer-wearing composition heel and sole.

3 A big step forward came with the introduction of a reversed cowhide shoe, with a composition sole and heel, reinforcing nails, and a riveted vamp.

4 The final step was the current combat boot with a full leather tongue. Boot reaches 10 inches up the leg to provide protection to lower part of shin.



new Tools

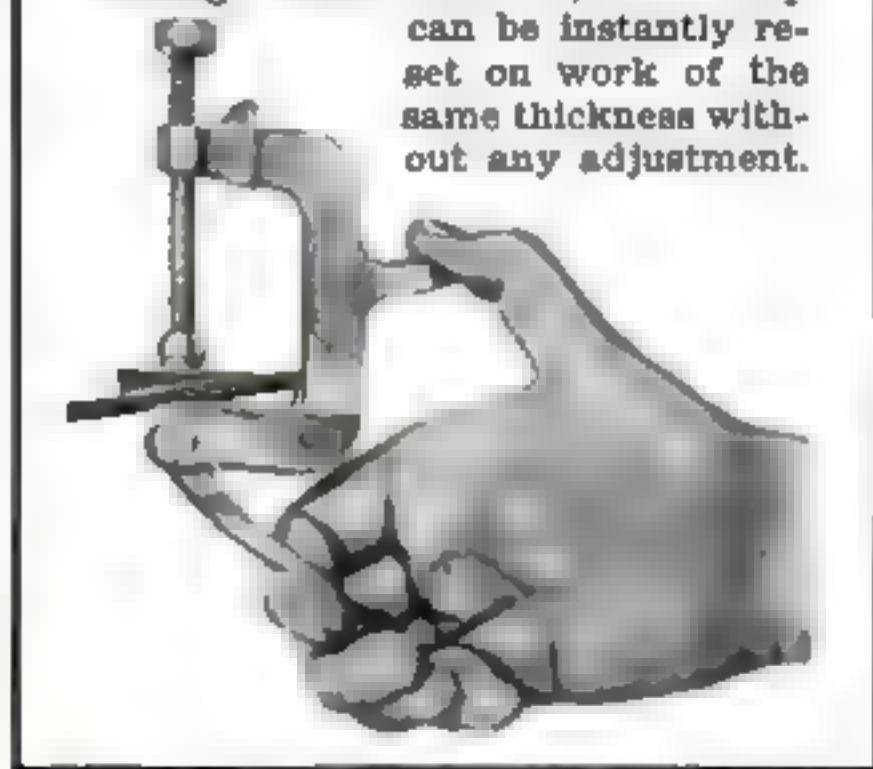
THIRTY TIMES as fast as previously used power-drilling methods, Boeing's new "porcupine" die punches 388 riveting holes into Flying Fortress catwalk parts in a single press stroke. Accuracy to 5/10,000 of an inch speeds assembly by insuring absolute alignment of matching parts. The die can punch through metal over $\frac{1}{8}$ inch thick.



A QUICK-ACTING LOCK holds any setting on the new Xactor vernier protractor, making it useful for mass gauging as well as single measurements of angles and depths. In measuring angles, the pocket-size instrument is accurate within one half of one degree. It is made by the Industrial Engineering Co., Chicago



A TRIGGER RELEASE on a new clamp offered by the Grand Specialties Co., Chicago, speeds light machining. When released, the clamp can be instantly reset on work of the same thickness without any adjustment.



KITCHEN knife sharpeners with added handles and guards are efficient burring tools used to smooth edges of newly-cut Curtiss-Wright warplane parts.

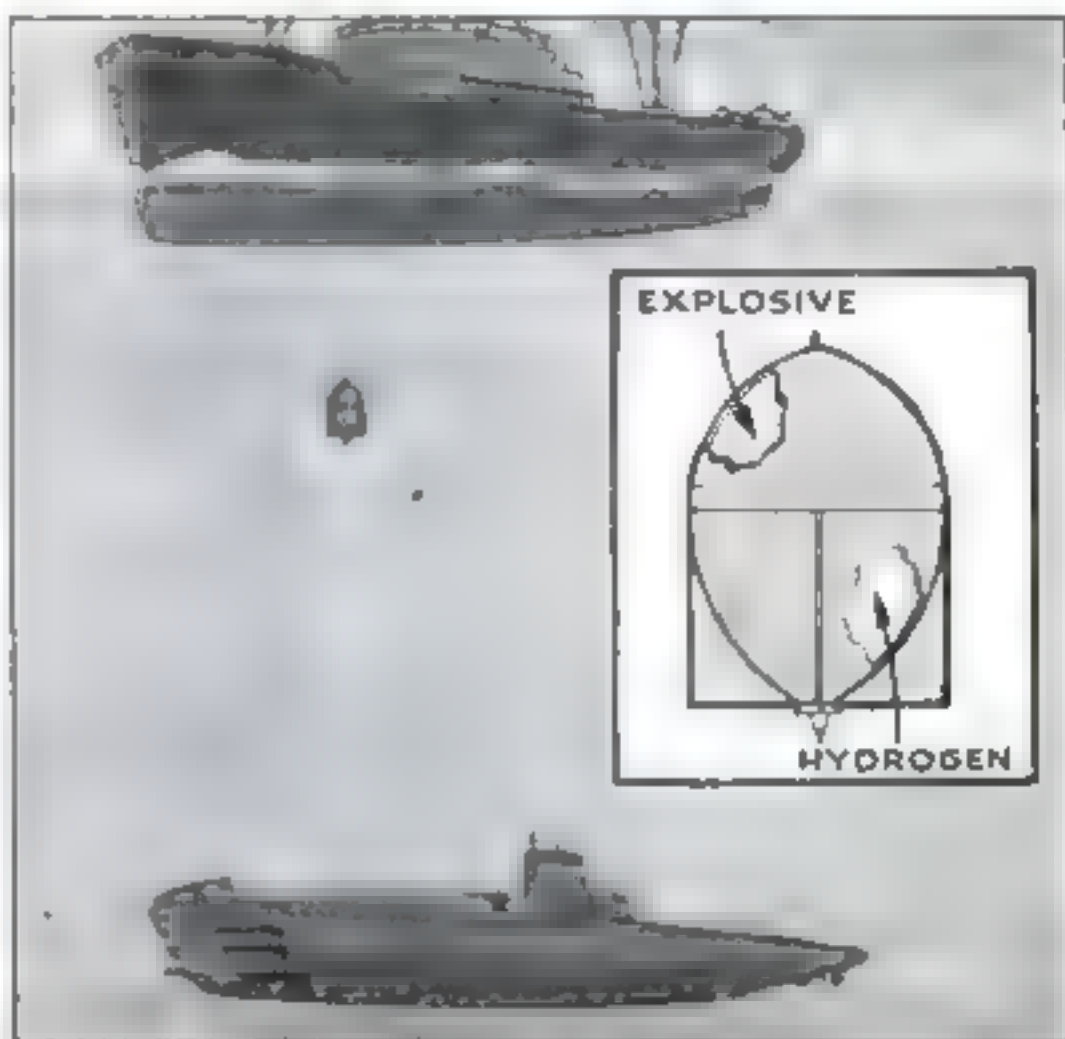




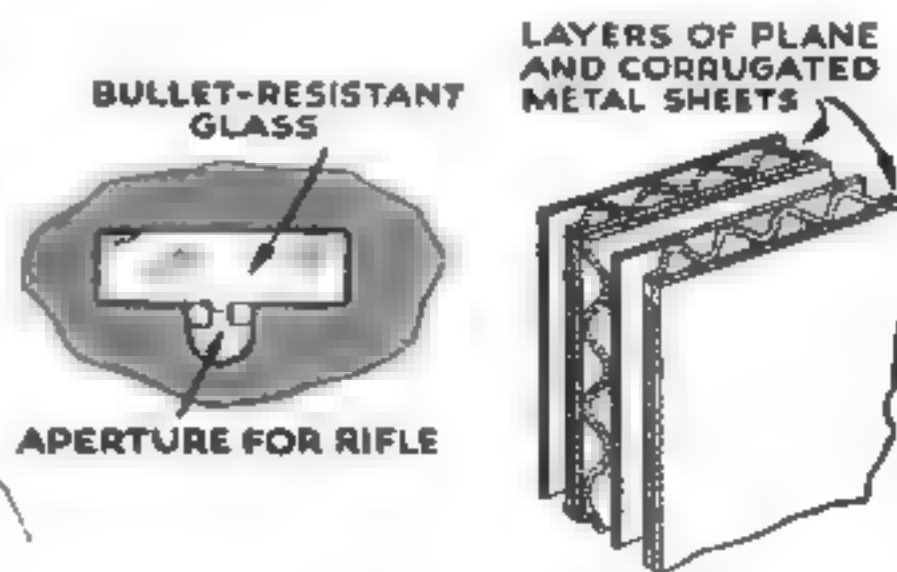
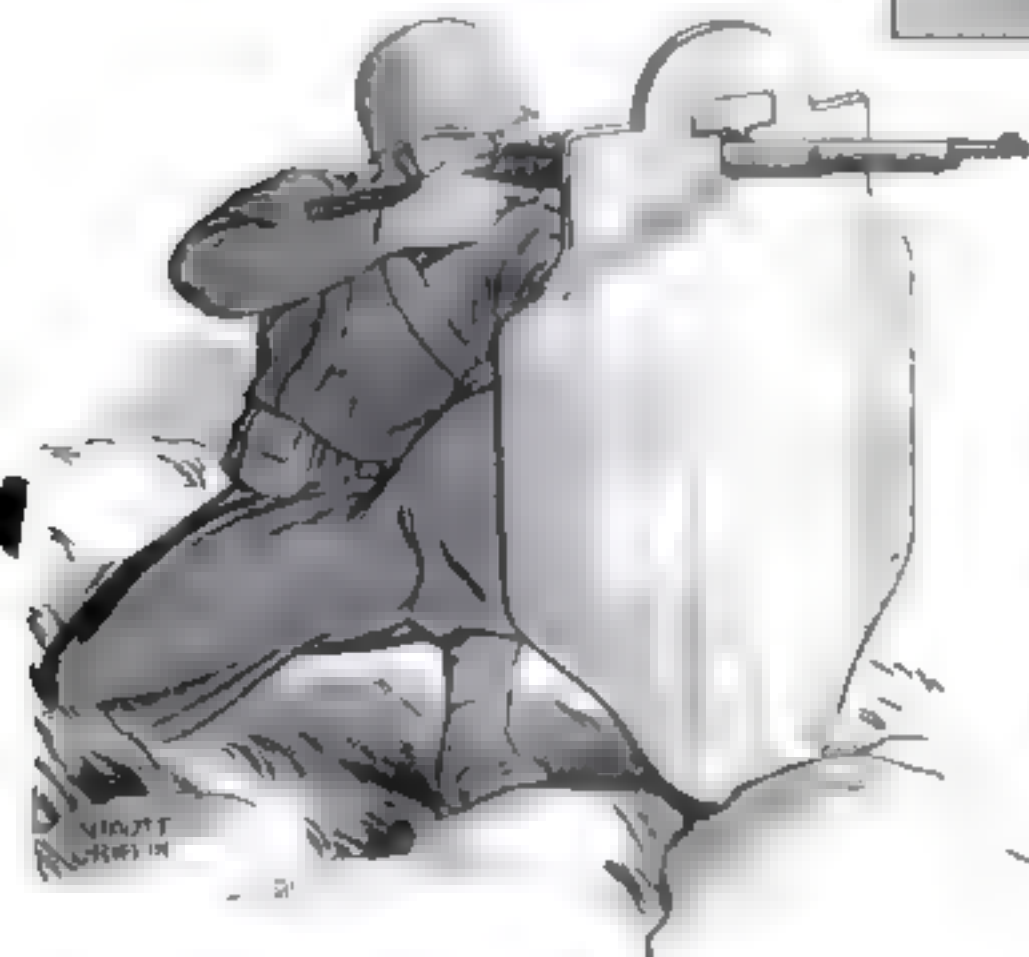
FLOATING ON ELBOWS in the wings instead of on separate pontons, this Claude Dornier-designed seaplane does away with the defects of conventional floats. An inte-

gral part of the wing the elbows do not increase air resistance. They have no struts to carry away under stress, and they prevent heavy and sometimes dangerous rocking.

"SURFACE-BOMBING" passing ships, Rafael Gimenez Ruiz, Philippine inventor, would reverse the depth-bombing practice to "drop" torpedoes up from submarines. His weapon is shaped very much like a conventional airplane bomb. The nose is loaded with explosive, while the tail, which is finned to guide the ascending torpedo, contains hydrogen to provide buoyancy. Contact sets off the charge. The torpedo would be released far enough below the surface to give the submarine time to get out of range before the explosion. Since the submarine would not have to approach the surface to discharge the new weapon, danger of discovery would be minimized, and the undersea craft would have an answer to the depth charges of surface vessels.



LAMINATED CONSTRUCTION makes the portable shield suggested by Paul H. Davey, Kent, Conn., light and effective. Set up on its supports, it provides full vision without exposure and allows a soldier unhampered use of his rifle.



Pain-Killers Save Lives

By IAGO GALDSTON, M. D.

Author of "Progress in Medicine" and
"Behind the Sulfa Drugs"

PHYSICAL pain is a disrupting force that must be eliminated as far as possible among our fighting men. It is a complex phenomenon whose analysis has taxed the best brains in medicine. We all know that, from an unpleasant sensation, pain may become intolerable. When it is intense and long continued, it changes the whole person. As W. K. Livingston stated in his book "Pain Mechanisms," "It interferes with thought processes, it disturbs sleep, impairs appetite, undermines morale, and may disorganize the functioning of every part of the body."

To allay pain, physicians can employ a vast variety of techniques and many drugs. These are fitted as closely as possible to the needs of the case. In some instances, a doctor is able to remove the cause of the pain. This, of course, is the ideal treatment. Very frequently, however, it can't be done. Then the physician can dull the receiving mechanisms of the pain sensations, or he can block the pathways (nerve tracts) by which the pain stimuli are transmitted, or he can so affect the brain, by means of drugs, that it does not perceive or register the sensation of pain.

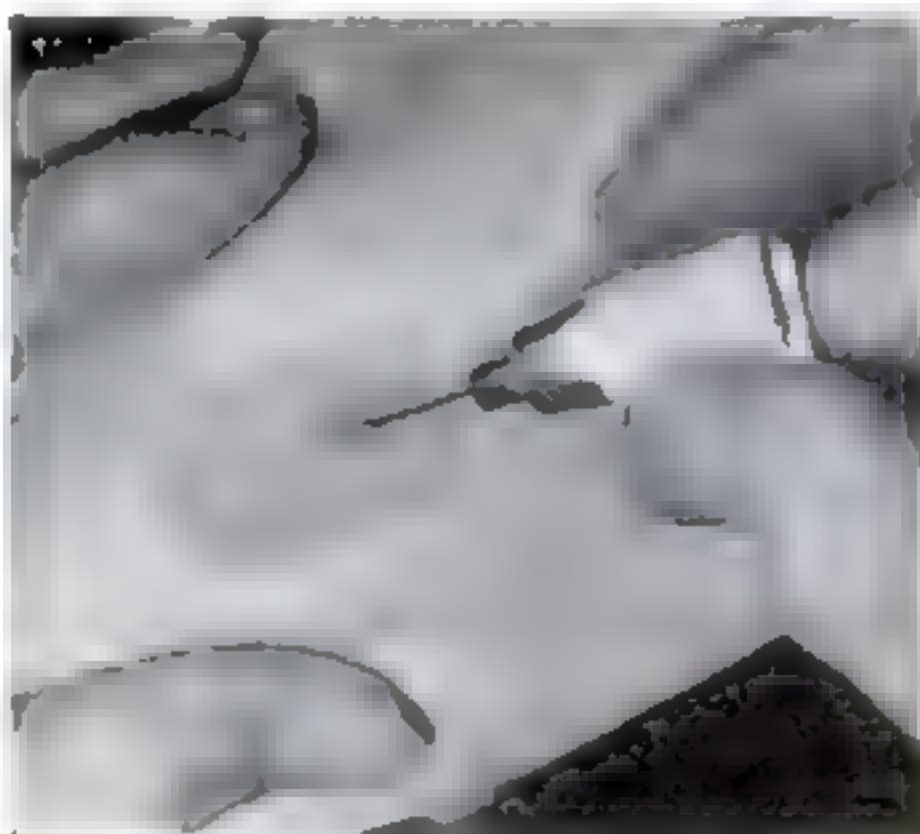
The last-named method is the one most commonly employed. The drugs most effective in "dulling the brain" against pain are morphine and its derivatives. It is in this connection that the new synthetic analgesic, Demerol, is important. This drug—created as a substitute for atropine and morphine—was first introduced in 1939. Its development not only adds a valuable agent to our analgesics, but promises to relieve us of dependence on foreign countries for opiates.

Precious as are the sulfa drugs and blood plasma, Demerol and the other pain-killers must rank first with the man in pain. This fact, coupled with the difficulties encountered in sterilizing needles and syringes in fighting areas, has stimulated development of convenient and practical units for quick administration of analgesics.

One of these units—meeting the strict specifications for such equipment—is being made in quantity by the Schering Corporation, Bloomfield, N. J. It is called the Hypomatic. A "one-shot" automatic injection instrument, it is a compact unit $4\frac{1}{4}$ inches long, consisting of a sealed, long-necked ampoule containing the solution to be injected and also an inert gas under approximately two atmospheres of pressure. Its sterile needle is protected by a removable glass tube that hugs the collar of the needle. Injection is made rapidly and simply, the gas expelling the analgesic automatical-



Shown above is a Syrette, a single-dose hypodermic unit carrying a 1.5-cc. solution of morphine tartrate. After needle's hood is removed, and the seal between the needle and the tube is punctured, needle is inserted (right), and contents injected by squeezing collapsible tube





Photograph from Parke, Davis and Company

Developed as a substitute for morphine, which must be imported, Demerol has proved a safer opiate that is highly effective in a wide variety of conditions ranging from asthma to childbirth

ly. It may be used with equal facility and effectiveness by tank and submarine crews, airmen, and other fighters far removed from normal medical stations.

Another single-dose hypodermic unit has been developed by E. R. Squibb & Sons, under War Department encouragement. It is called the Syrette, and consists of a collapsible tube, the neck of which is affixed to a hypodermic needle.

Found on the wartime list of analgesics is an old friend—cold—in a thoroughly new

guise. Producing analgesia by freezing, which employs a spray of ethyl chloride, is an old technique. It has long been used to desensitize the skin around sore areas. This technique has largely been replaced by infiltration—the injection of analgesics such as novocain. But another form of freezing has been developed and is proving of real value. It dates back to 1938, when Dr. Temple Fay, of Philadelphia, sought to arrest growth of cancer by lowering the patient's body temperature. In experiments,

As in other types of medical laboratory work, experimental animals such as rabbits and monkeys are often employed to test the effectiveness of a newly developed anesthesia. In testing a local anesthetic, the solution is applied in a rabbit's eye



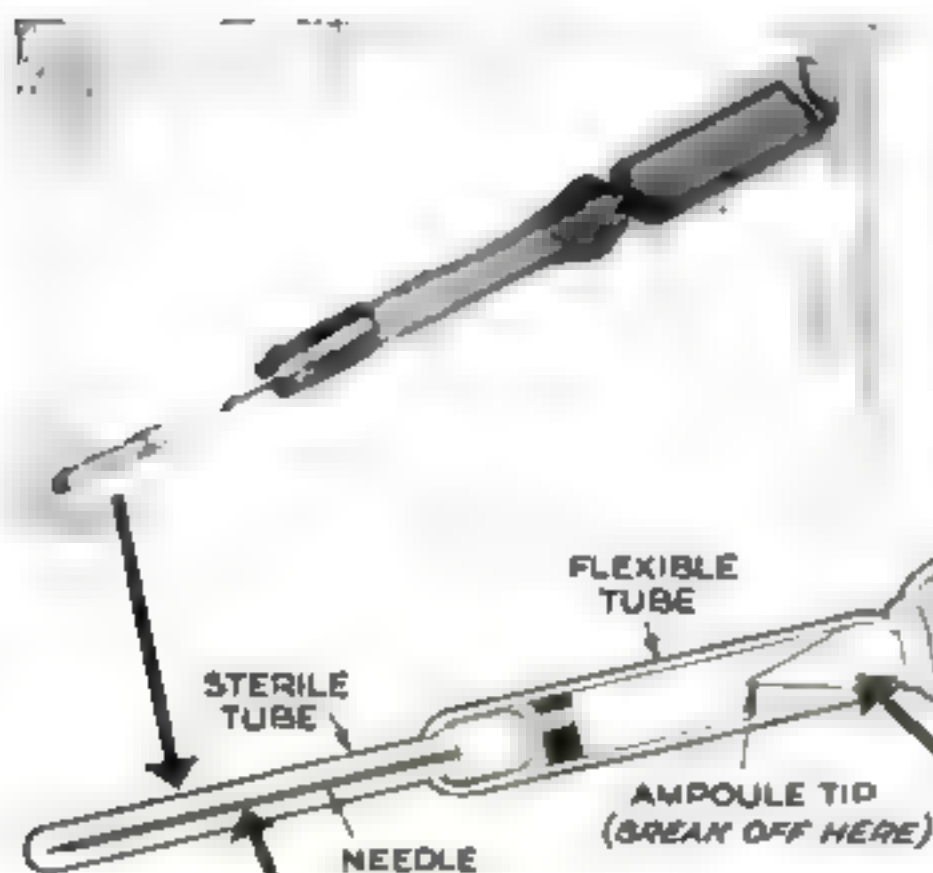
subjects were packed in ice. Their body temperatures declined. They became drowsy and relatively insensible. As a treatment for cancer, "body freezing" proved valueless, but, as is frequently the case in science, the experiment which failed in one respect proved fruitful in another. In this instance, it was found that freezing relieved intractable pain. Dr. Frederick M. Allen, of New York, used it to develop a surgical treatment for gangrene of the extremities. He applies packed ice to the part after constricting it with a tourniquet. Amputation can then be made without additional analgesics, and the patient suffers no pain and virtually no shock.

No less interesting are the new ways in which the old and well-established analgesics are being used. For instance, there is the recent application of spinal analgesia to obstetrics to produce painless childbirth. It is in the form of the so-called continuous

caudal analgesia, which is a new and novel extension of the technique to deaden the lower nerve centers of the spinal cord so that they do not transmit any sensation of pain.

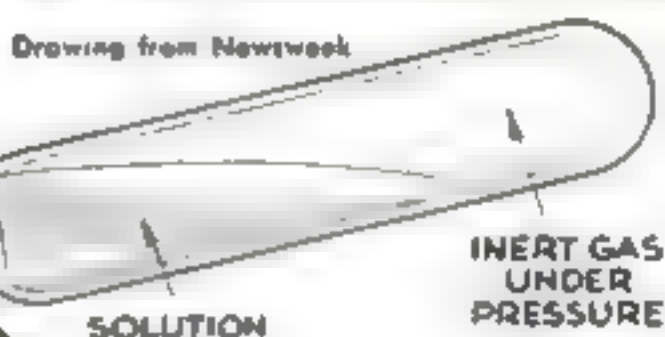
Analgesics are being used effectively in psychotherapy in Britain and the United States. They produce prolonged sleep and also a mental state not unlike that seen in hypnosis. The prolonged sleep is applied to relieve the sufferers of intense emotional excitement and anxiety. The hypnotic state is utilized for diagnosis. In a condition of "half-sleep," the patient can understand and respond to questions. His critical faculties become such that he is inclined to talk freely about things he ordinarily would suppress or would not remember. By means of this type of hypnosis, the psychiatrist is frequently able to arrive at the crux of the patient's difficulties in a shorter time than would be required in other forms of therapy.

AUTOMATIC HYPODERMIC MAKES INJECTIONS FOOLPROOF



Similar to the Syrette in that it is a single-dose instrument is the automatic hypodermic known as the Hypomatic. After removal of the sterile tube that protects the needle (left), the syringe is applied as shown at lower left. By bending the plastic tube that joins the needle and vial, the ampoule tip of the vial is broken to release the solution, which is driven through the needle and into the tissues by inert gas. Considered 'foolproof,' the syringe can be used safely even by an inexperienced layman

Drawing from Newsweek





UTTER DESTRUCTION is the story to be read in this air photo of the Focke-Wulf warplane plant at Marienburg, East Prussia, after a precision-bombing visit by Flying Fortresses of the Eighth Air Force

TO a layman, many an aerial photograph of a bombing objective resembles an amateur cameraman's first attempt—and an unfortunate one at that. Looking at the same reconnaissance picture, an Air Intelligence expert sees trenches, machine guns, houses, factories, railroads, and highways.

Likewise, after bombers have done their work, new photographs often fail to show impressive evidence of destruction to the layman's eyes. But the art of the trained photo interpreter reveals telltale signs of war plants knocked out of production, of ruined airport runways, and of crippled rail centers.

An amateur can easily learn at least the ABC's of reading aerial photographs—a fascinating detective game of making shrewd deductions from simple clues. While some of the methods that professionals use must remain strict military secrets, enough can be told here to make pictures from the air far more intelligible to a novice.

Any city, town, or countryside may provide landmarks to guide raiders, or may take on military importance in a land campaign. Suppose, therefore, we start with a strategical background of familiar landscape features. Of course they will look strange from

How to Read Aerial Photos

**RECONNAISSANCE SHOTS
YIELD TELLTALE CLUES
TO TRAINED EYES. TRY
YOUR OWN SKILL AT IT
—AFTER READING THIS**

By

ALDEN P. ARMAGNAC



PARK—or camouflage for AA guns? An odd piece of landscaping for a Nazi tank assembling center, it was plastered by RAF



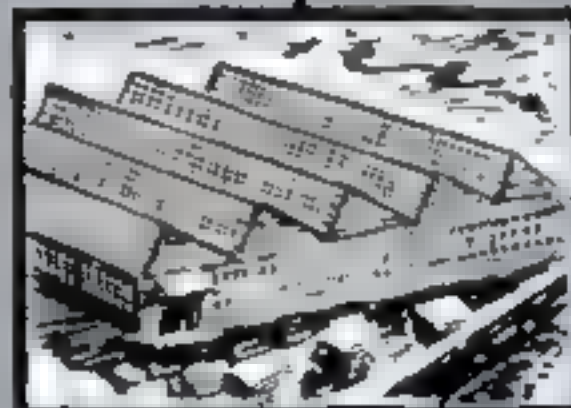
ARMORED VEHICLES, just off the assembly line, offer a prime target. Their destruction means wasted work, materials



SHED is identified by shape and shadow. With the time of day known, length of shadows reveals height of buildings



RAILROAD CARS give away the location of vital slings. Bombs here hit transportation



FACTORY SHOPS are plainly marked by sawtooth roofs. Here is needed production machinery

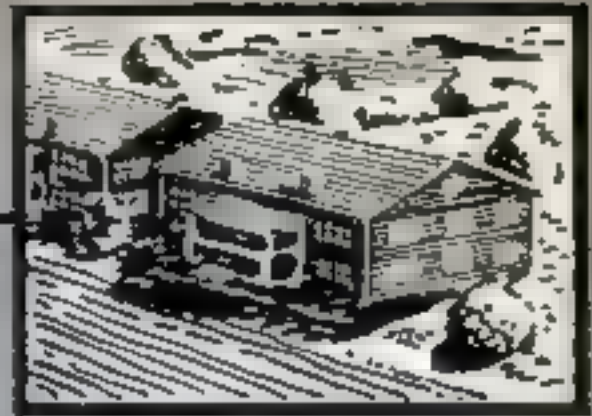
the air, because we are accustomed to seeing them sideways and not from overhead. To identify an object, the most important aids include its shape, its lightness or darkness, its shadow, and its size.

When a long, straight line crosses an aerial photo, you need not look for locomotives or cars to arrive at the conclusion that it is a railway. If it does have curves, they will be gradual, in accordance with standard railroading practice. Conversely, a series of straight lines joined by sharp curves must be a motor highway. Simple, isn't it?

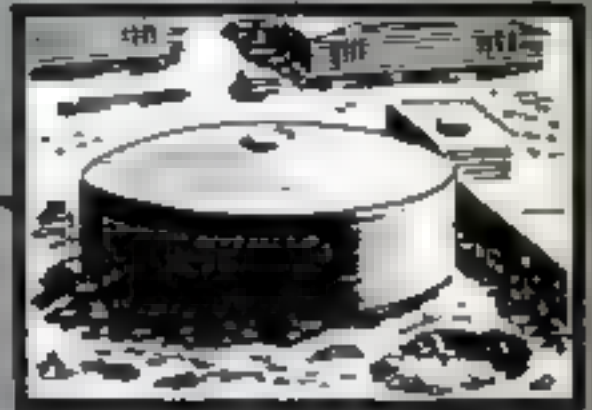
It may take more imagination to decide what to make of a chevron-shaped swath cut through a forest. A person experienced in looking at air views will recognize it as a clearing for a high-tension electric transmission line. Once you are in on the secret, the simplest geometry points to the tower where the wires change direction. Because of their way of marching across country with little regard for topography, high-tension wires are easily recognized.

Perhaps you will puzzle at first over one of the most easily identified features of an

AFTER BOMBING



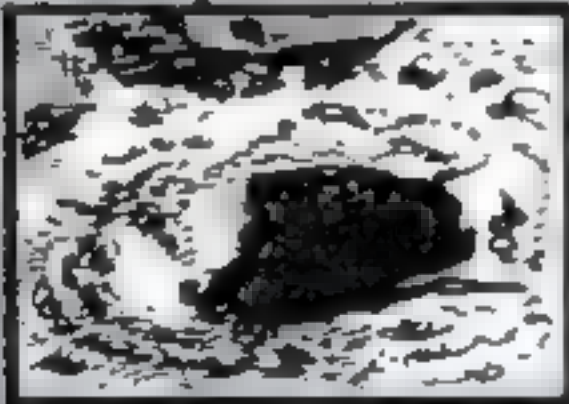
WORKMEN'S HOMES must share the risk if they are situated so near a target. Some of these are without roofs, showing bomb hits.



STORAGE TANKS are easily identified, and bombed if they are considered important. This one apparently was not aimed at.



FACTORY will be out of business for some time, judging by the peppered condition of the roof. Experts can tell how long.



BOMB HIT is recorded by this white splash. Surroundings are wrecked, vehicles have vanished.



RAILROAD YARDS are now a mass of twisted rails, smashed switches. Repairs will be slow.

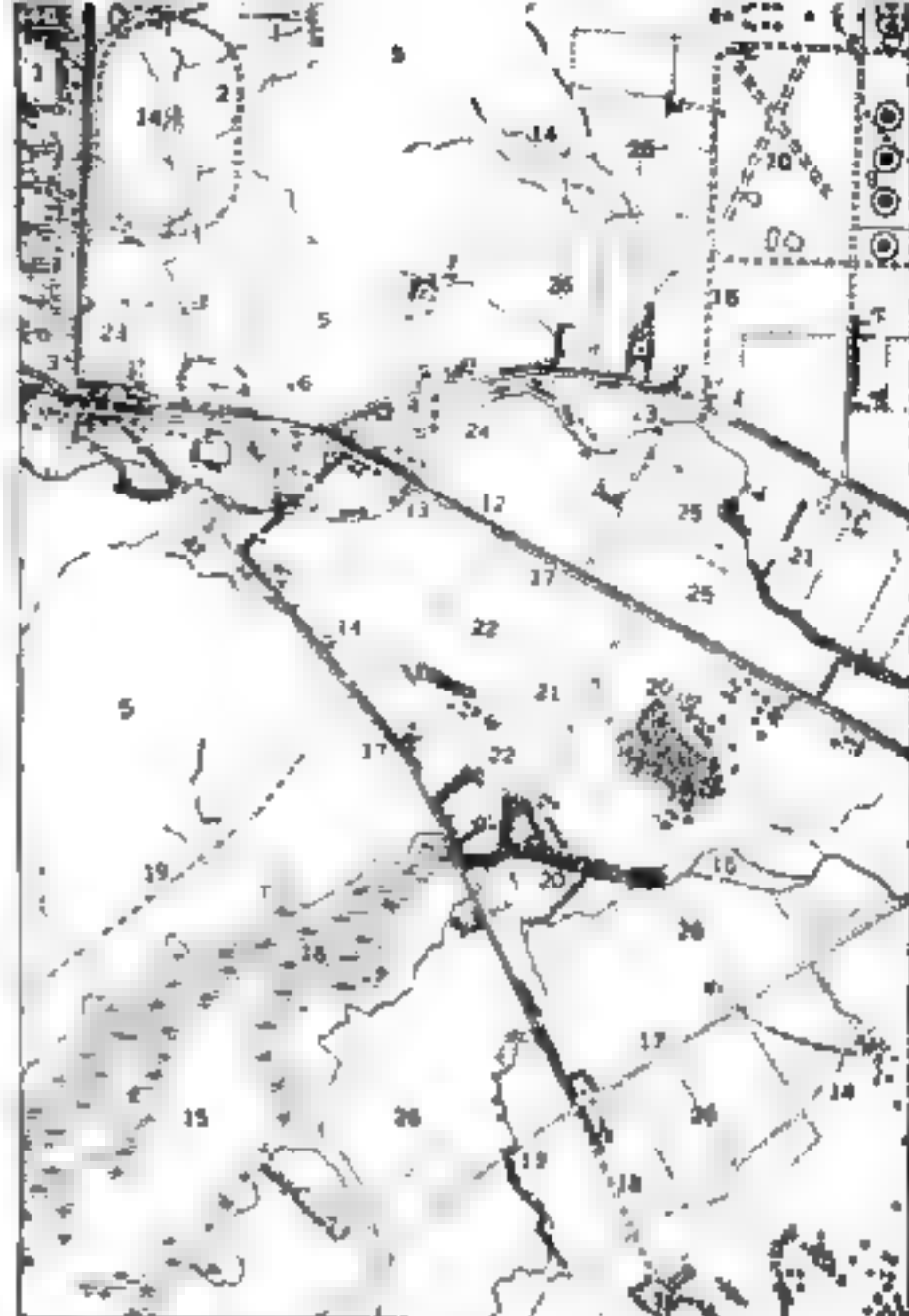
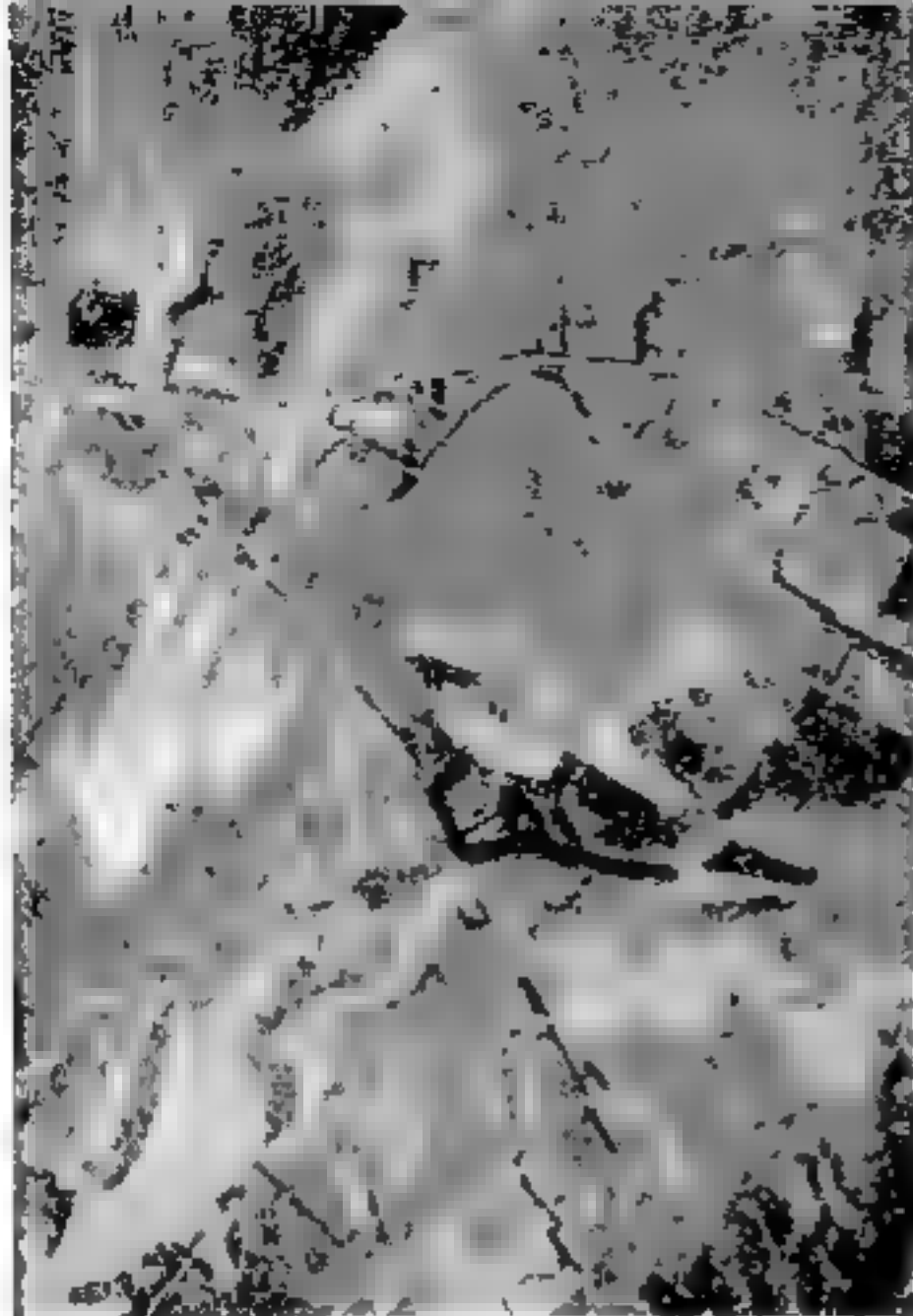
air view—a pattern of black dots neatly arranged in rows and columns. It is an orchard, and the dots are the trees.

Natural features of a landscape readily distinguish themselves from the regular patterns of man-made objects. The wandering course of a stream, for example, could hardly be mistaken for anything else.

Gradations from white to black, called tone or texture, tell a story of their own. Roads, which reflect light well, show up in light tones—the more heavily traveled, the lighter. Plowed fields, too, are good reflec-

tors. Meadows look darker because of shadows cast by the grass, just as plush looks darker than satin of the same color. Woods, heavily shadowed by trees, appear very dark. Cultivated fields range through a variety of intermediate tones of gray, from which an expert can often determine just what crop is being grown! A body of smooth water may show up light or dark, according to the angle of the sun, whose rays it reflects like a mirror instead of scattering them like loose soil.

Face a window or light, and hold an aerial



FROM PHOTO TO MAP. Interpretation of detail on an aerial photograph is illustrated above by the comparison of a vertical camera shot with a keyed map based upon it. Note how highways show up as white lines with angular turns; railways have gradual curves. Points of special interest to a bombardier are rail yards (3), oil tanks (9), airport (10). The curious oval in the upper left-hand corner (14) is the race track at the fair grounds

photo with its shadows toward you. This correct way of viewing it prevents hills from being mistaken for hollows, and craters for mounds. Besides giving an illusion of relief, shadows also indicate shape and size. An oblong object, half bright and half dark, turns out to be a house with slanting roofs, one roof slope faces the sun while the other is in shadow. If you know the time of day when a picture was taken, the height of a building may be compared with its length and width by noting the length of its shadow on the ground.

In scaling the size of objects, comparisons help. A truck on a road gives an idea of the road's width; and the size of a warehouse may be estimated with respect to a dwelling.

Supplementing each other as they do, these clues lead to further deductions. A likely place to look for a bridge is a narrow part of a river. A picture shows a well-traveled highway leading to such a point. Closer examination reveals the bridge itself—which looks lighter than the water, and further reveals itself by its size, shape, and shadow on the stream. In the art of aerial photo interpretation, as in chemistry and many other fields, a skilled analyst has a prett-

good idea of what he is going to find before he finds it.

Superimposed upon ordinary terrain, military works reveal themselves to the eye of the flying camera. Trenches, reappearing in the present war, stand out by virtue of their zigzag pattern, or that of the earth dug out to make them. "Foxholes" can usually be picked out by their sharp outlines and deep shadows. Wire entanglements show up as broad lines or ribbons—accentuated, if newly laid, by the tracks of working parties. Similar tracks betray frequently visited machine-gun positions. Grass trampled by soldiers may be clearly distinguished from other growth. Any disturbance of nature's patterns is a sure sign of human activity. Neither telephone posts, their shadows, nor wires can usually be seen in reconnaissance photos—but the earth removed to sink the poles, and the trails left by construction crews, make a series of small, regularly spaced dots connected by a thin line. As might be expected, a photo interpreter with tactical training benefits by knowledge of how he would dispose his own troops, guns, and headquarters in a similar situation.

Permanent tar- (*Continued on page 199*)

new ideas from the inventors



RUBBER COVERED
LEGS

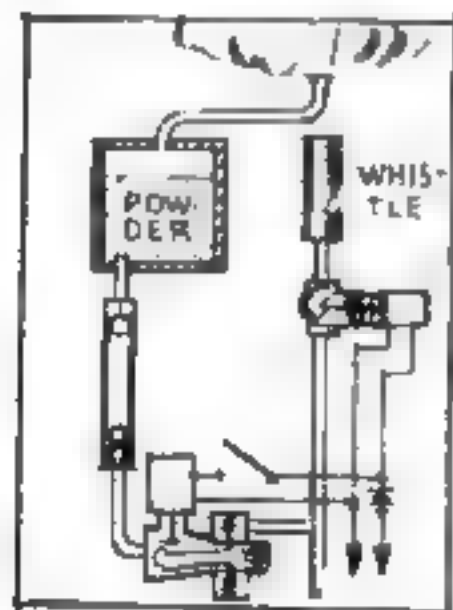
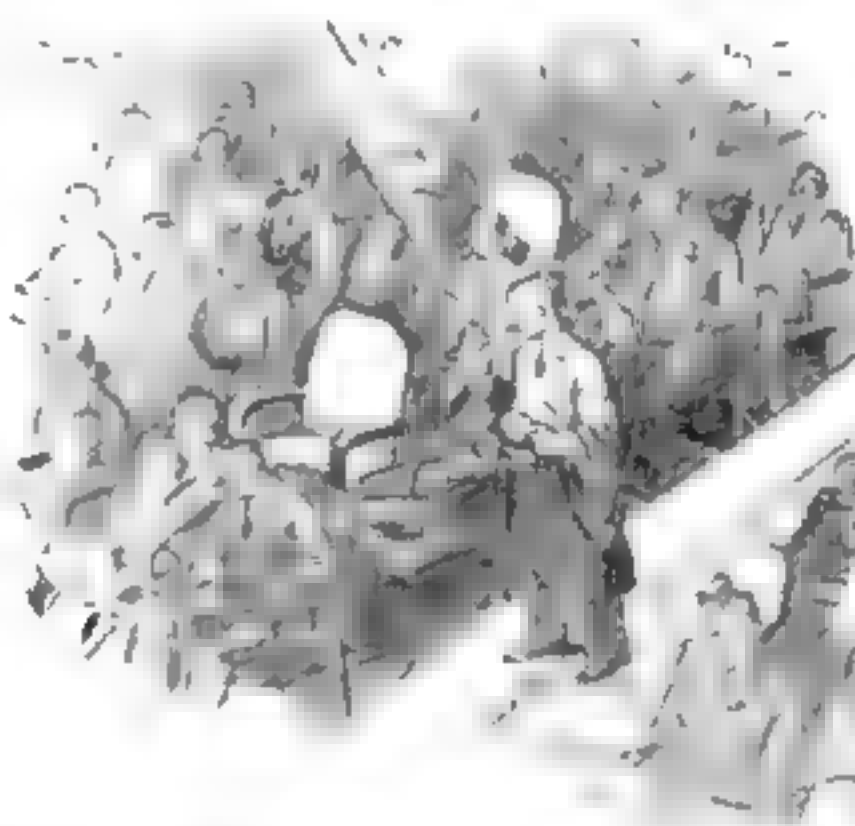
EYEGGLASS



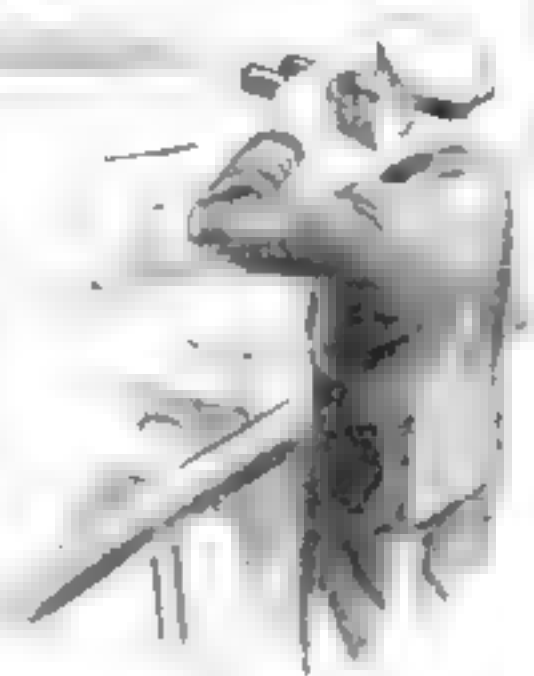
SELF-CLEANING eyeglasses invented by Isidor Greenfield, Brooklyn, N. Y., may solve the familiar problem of constantly fogging lenses.

Twin windshield-wiperlike blades move across both surfaces of the lenses like the hand of a clock when a knob is rotated in a slotted support around the spectacle-frame rim. Industrial usefulness is possible for the inconspicuous wiper, which is easily attached to, or removed from, the lens rim.

GLOWING SEATS and carpets to guide entering moviegoers to empty seats are the suggestion of James H. Owens, Camden, N. J. Sit down and you automatically black out your seat, giving fair warning that it is occupied. Source of the glow would be fluorescent dyes activated by invisible ultraviolet rays blanketing the theater. As pointed out by Owens, steady patrons would gradually acquire a healthy ultraviolet sun tan, in addition to their entertainment.



IMITATION STEAM made by puffing a cloud of powder from a reservoir by compressed air supplements the "invisible" note of the air whistles used on Diesel boats and helps distinguish which ship is signaling, in the latest idea proposed by John Hays Hammond, Jr., noted inventor.





Testifying to the wide use the Germans make of land mines is this gigantic dump of Tellermines, which was captured by Allied troops when they chased the fleeing Nazis out of Sicily.

THIS IS THE ENEMY'S DEADLIEST DEFENSIVE WEAPON.

HOW AXIS LAND MINES WORK

Sown by millions to slow our advancing troops, they must be removed by experts who know all of their fiendish tricks.

By HAL BORLAND

Photographs by WILLIAM W. MORRIS

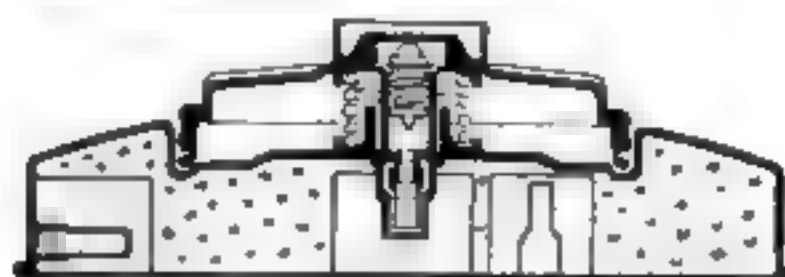
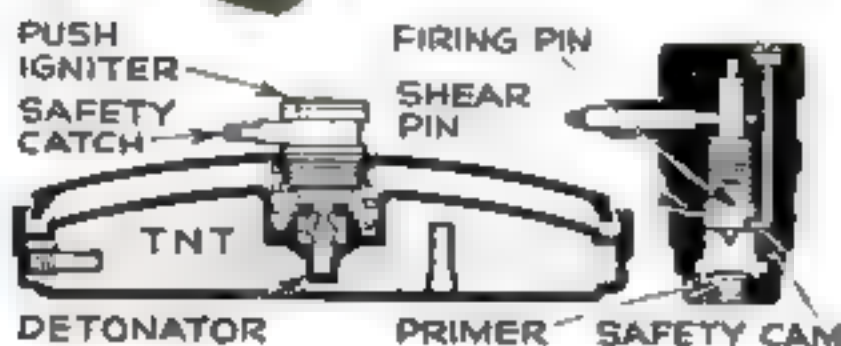
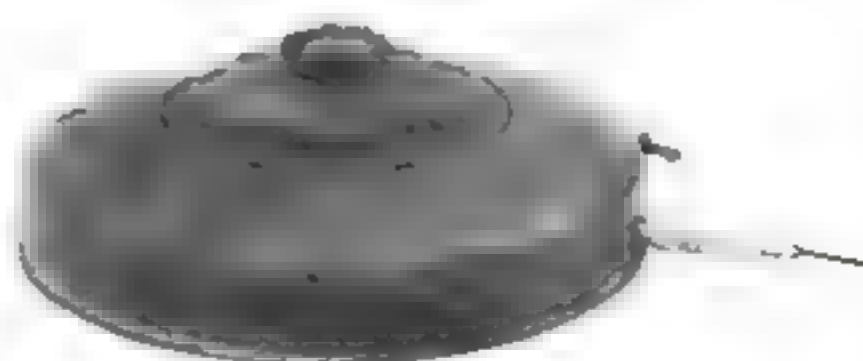
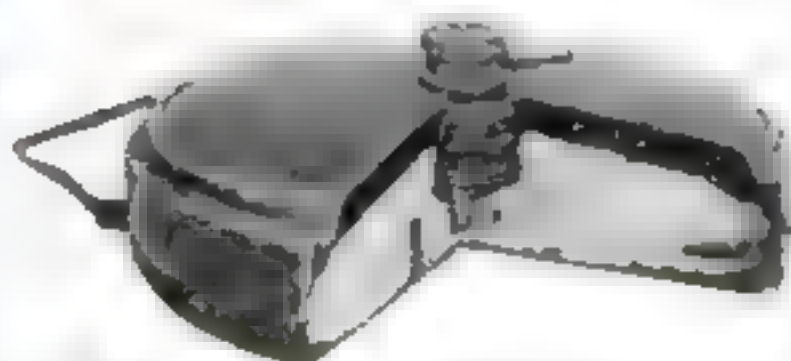
THE dragon's teeth of this war are land mines, sometimes rated the most devilish defensive weapons man ever devised. The Axis has used them by the millions in Africa, on the beaches of Sicily and Italy, in the Pacific island areas. Every land avenue to Hitler's Inner Fortress is virtually paved with them. It is estimated that in some theaters, such as Italy, as much as 40 percent

of Allied casualties are caused by mines.

Essentially the land mine is an explosive charge which is set off automatically when a man or vehicle touches it or approaches it. Cheap to make, light to transport, and easy to install, it is as hard to find as a sniper, as dangerous to disarm as a commando. To cope with it, the Army Engineers have developed a corps of specialists who have one of the most dangerous, nerve-racking assignments in the back. It is their job to clear the way for every land advance of our troops, and they know as much about land mines as the men who make and install them, which is plenty.

There are two principal types of land mines: antitank, designed to destroy vehicles, and antipersonnel, designed to kill men. Antitank mines are hidden in the ground and are set off by the weight of a passing tank or truck. Antipersonnel mines may

THESE ARE THE TANK-KILLERS



GERMAN TELLERMINE I. Above, a sectional diagram of the mine (top), whose case has been partially cut away to show construction. This model has been designed so that pressure anywhere on the top will cause it to explode

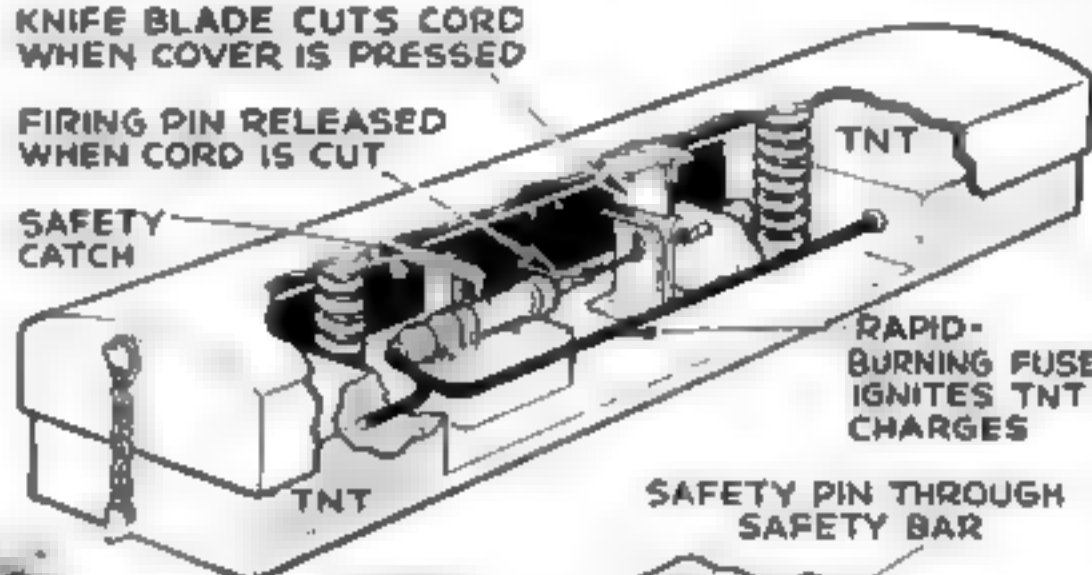
TELLERMINE II. Above, sectional diagram of mine (top). This model's small pressure plate keeps mine from exploding until passing vehicle is directly over mine. Each Tellermine model contains 11 pounds of TNT

ITALIAN road mine is simple as a mousetrap. It consists of a metal box four feet long and eight inches square, with loose cover set on springs. Between two four-pound TNT charges, one at each end, is a striking arm held under tension by a cord. Pressure on the cover lowers a knife that cuts cord, releases striker, causes TNT to explode

KNIFE BLADE CUTS CORD WHEN COVER IS PRESSED

FIRING PIN RELEASED WHEN CORD IS CUT

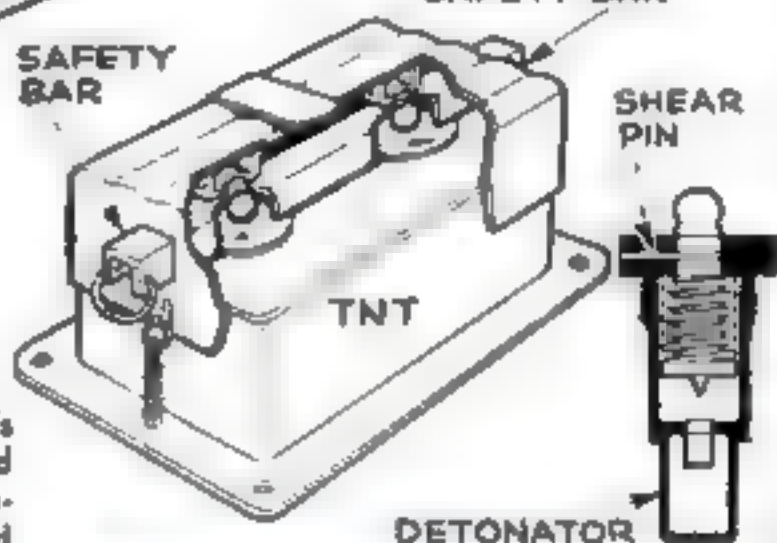
SAFETY CATCH



RAPID-BURNING FUSE IGNITES TNT CHARGES

SAFETY PIN THROUGH SAFETY BAR

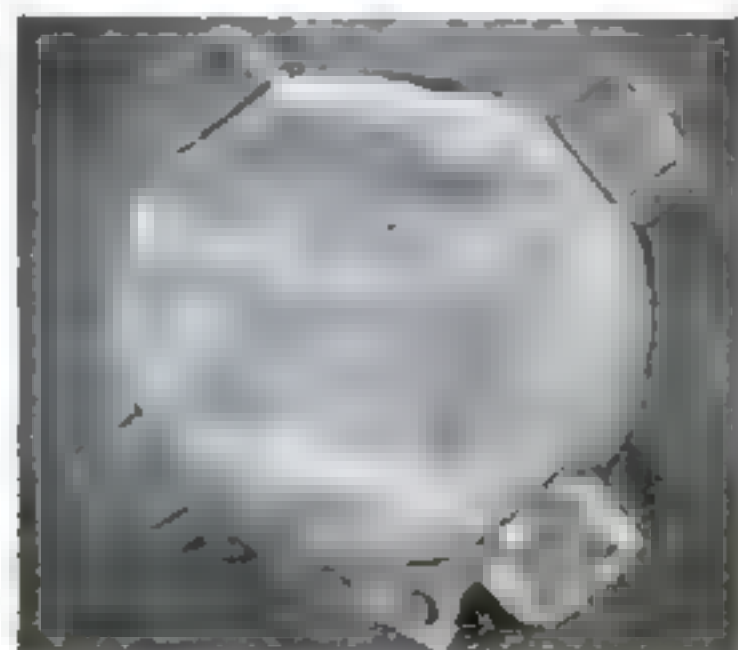
SAFETY BAR



DETONATOR

FRENCH "waffle iron" (sectional view at right) is shown without loose-lid arrangement. When pressed down, lid hits igniters (one of which is shown removed) to set off mine's six pounds of picric acid

JAPANESE mine (below) consists of two pounds of picric acid, is set off by pressure on button at top center. Jap "satchel bomb" (right) is canvas case carrying 1 1/2 pounds of picric acid, and fitted with four magnets and delayed fuse. Japs slap these bombs on the sides of tanks as they go past



be hidden in the ground, among trees, in buildings, or in any kind of booby-trap setup. They may be set off by pressure or by trip wires, and some varieties leap from the ground and explode at waist height.

All land mines have two basic parts, the explosive charge and one or more firing devices or detonators. Antitank mines do their damage by explosive force alone; anti-personnel mines hurl projectiles, like mortar shells or shrapnel. In both categories, those developed by the Germans are the most fiendish and complex.

The German Tellermine, an antitank charge, is typical. It looks like an overgrown discus, 16 inches in diameter and four inches thick, and contains 11 pounds of TNT, which is set off by pressure on the top of the mine. Its blast can blow a jeep to bits, tear off a tank tread, or rip open a tank's belly and kill or maim everyone inside. There are two types of Tellers. No. 1, the older, is exploded by pressure anywhere on its top plate; a tank can nudge it and escape with minor damage. No. 2 has a smaller pressure plate which insures a knockout for any vehicle which sets it off. No. 2 also has a fluted top which holds drifting sand and makes it easier to camouflage.

The Teller's pressure detonator, a screw-in device with a firing arm held under tension by a shear pin, can be removed with relative ease by a mine expert. But this mine has two auxiliary detonators, on the side and in the bottom, equipped with trip wires usually set to entangle anyone who disturbs it. And, as a final touch of devilry, Tellermines are sometimes "pancaked" in a hole with a maze of trip wires tying them together.

Compared with the Tellermine, the Italian road mine, which the Germans sometimes use, is as simple as a mousetrap. Basically, it is a metal box four feet long and eight inches square, with a loose cover set on springs. In a compartment at each end is a four-pound charge of TNT. Between these charges is a percussion cap and a spring-driven striker arm held under tension by a cord. On the loose lid is a knife blade which cuts the tension cord when the lid is pressed down. There are no auxiliary detonators.

The Japs use a road mine which looks like a small edition of Tellermine No. 1 and contains two pounds of picric acid set off by a pressure detonator. These Jap mines are also pancaked to make a particularly dangerous trap for man or vehicle.

The pressure detonators on these Axis antitank mines, except the Italian, are of two fundamental types: shear-pin and ball-bearing. In the shear-pin type, a firing arm is held under tension above a percussion cap by a pin of soft metal, which breaks when

additional pressure is applied. In the ball-bearing type, the striker arm is held up by ball bearings which, under pressure, are forced into recesses and release the firing pin. Both types of detonator have a safety device, usually a hole through the firing arm where a pin can be inserted to prevent its release. With this pin in place, the detonator usually can be unscrewed and removed "safely." (The word is the Engineers'; to the layman it may seem something of an overstatement.) Even with the pressure detonator out, there may be auxiliary firing devices of the unpredictable kind used in antipersonnel mines.

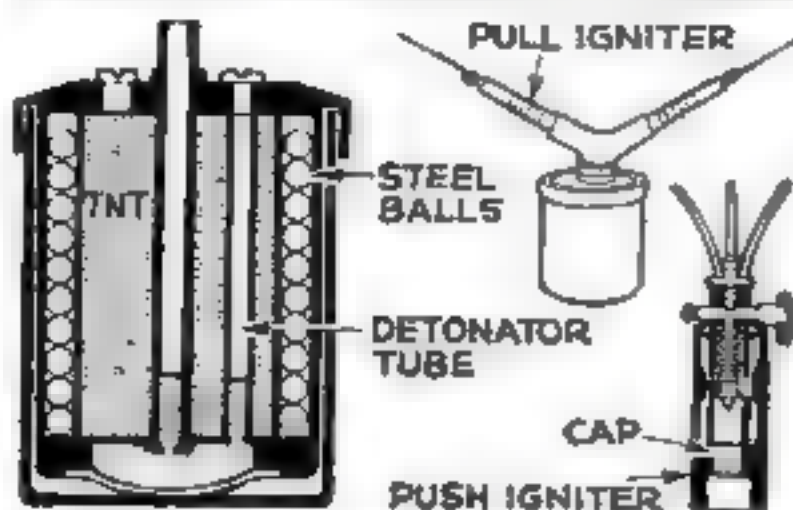
Of all the antipersonnel mines in the Axis armory, the German S mine is the trickiest. This is the jumping mine, the one which hops out of the ground and explodes at belly height. It is really a bomb, a pound of TNT surrounded by half-inch steel balls in a thin metal case. This bomb fits into an open can which acts like a small mortar, when the firing device is actuated, a light powder charge under the bomb element boosts it into the air, where a delayed-action fuse explodes it like a shrapnel burst.

The S mine takes either a sensitive pressure detonator with three wire prongs or a tension detonator fitted with a trip wire. Both types work on either the shear-pin or the ball-bearing principle, and either can be used as an auxiliary in the Tellermine. S mines are nearly always scattered through fields of Tellermines, to make the "delousing" job doubly hazardous. If there is a more terrible type of mine, our men have not yet faced it. The S mine will kill men 100 yards away, yet there is a safety area, a circle about six yards wide centering on the mine itself. A man who knows he has tripped one off has a fair chance to escape by taking one or two steps away from it and falling flat. And some experts say that if a man feels the pressure prongs under his foot he can force the mine to explode in the ground by standing on it. That's something like smashing the head of a rattlesnake by leaping on it with bare feet. But men have done it and lived.

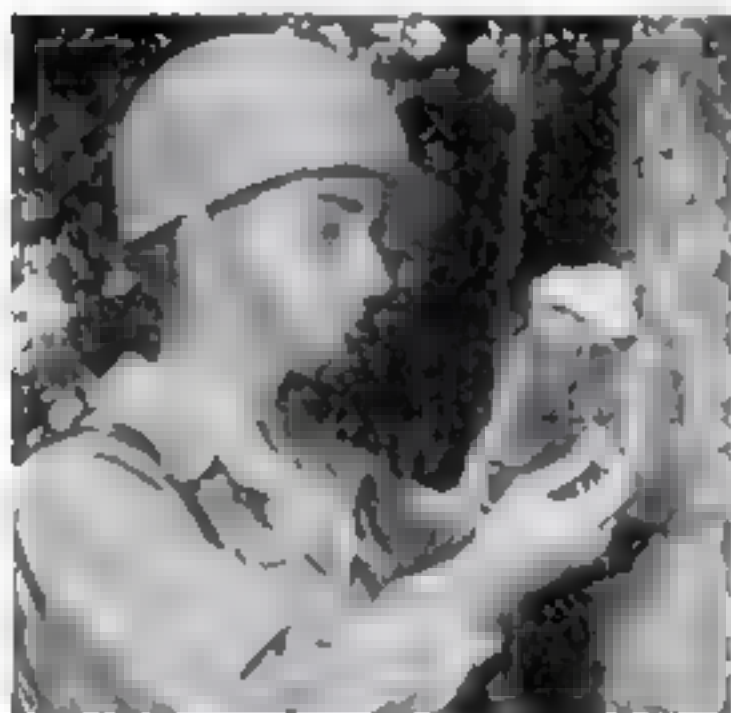
The Italians developed a picket mine, really a bomb, for field use. It is simply a cylinder of TNT wound with brittle wire, fitted with a trip-cord firing device, and fastened to a stake. When set off, it hurls wire fragments in all directions and inflicts horrible wounds.

These weapons are used in any number of combinations, particularly in defensive tactics. The Germans, for instance, have planted as many as 5,000 Tellermines in a coastal area a quarter of a mile wide and less than half a mile long, and along with them 1,000 leaping *(Continued on page 207)*

THESE ARE THE MAN-KILLERS



GERMAN S MINE is a fiendish device that leaps off the ground waist-high and hurls 360 half-inch steel balls in every direction. Carrying a pound of explosive, which is ignited by a delayed fuse, it fits in a canister from which it is tossed by a light charge. As shown above, it can be equipped with three-pronged push igniter, or pull igniter fitted with a trip wire.



ITALIAN mine is similar to the German mine, except that it is stationary, being fitted with pins by which it can be attached to a tree or wall. It contains about a pound of explosive and several pounds of steel balls or scrap iron. An unusual feature is a compartment in which are carried variously colored rolls of cord to be used as trip wires. Igniter operates on the push-pull principle: either too much tension or not enough tension will cause the mine to explode. Because of this, the mine has been found particularly adaptable to use in booby traps.

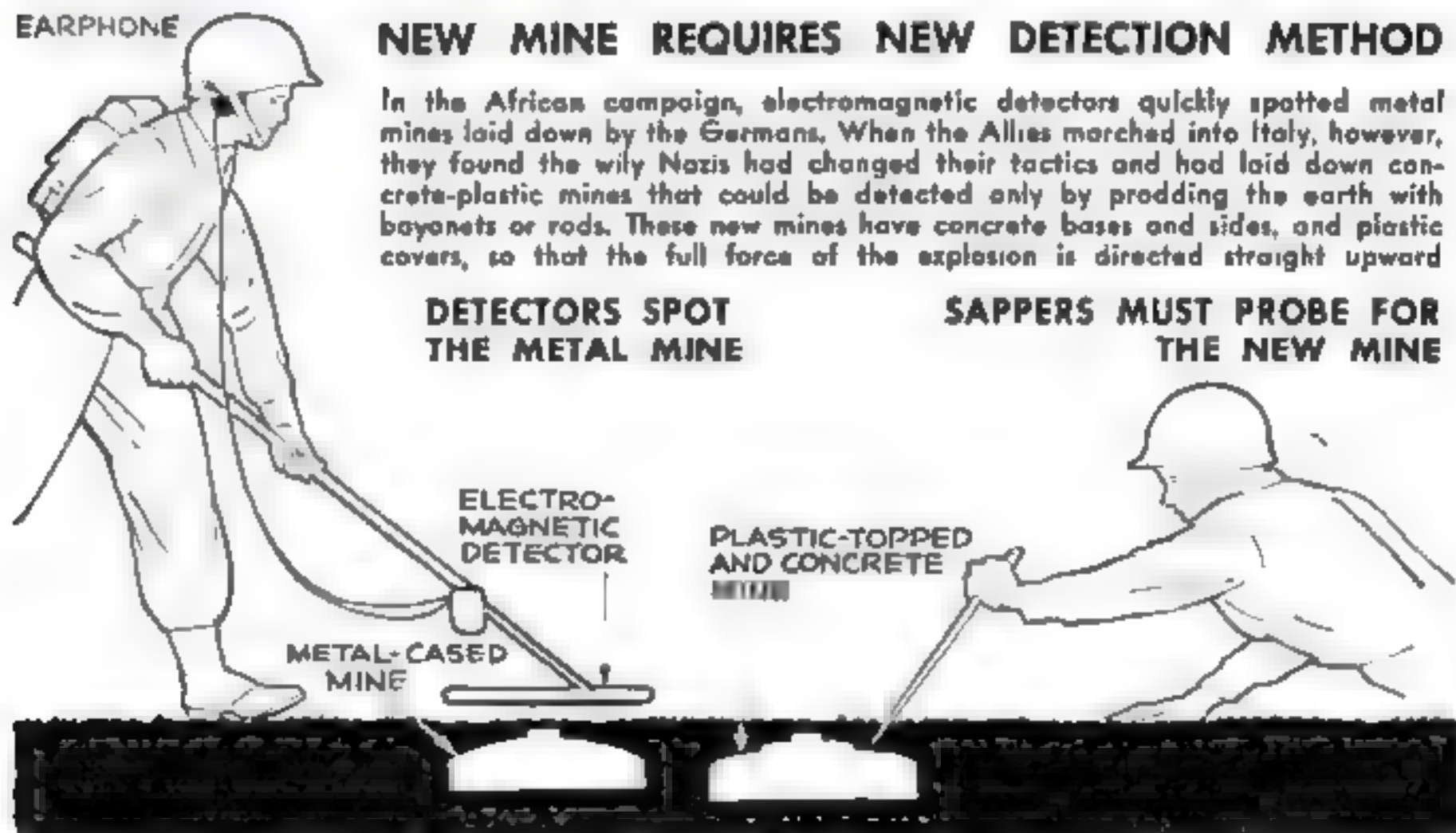
EARPHONE

NEW MINE REQUIRES NEW DETECTION METHOD

In the African campaign, electromagnetic detectors quickly spotted metal mines laid down by the Germans. When the Allies marched into Italy, however, they found the wily Nazis had changed their tactics and had laid down concrete-plastic mines that could be detected only by prodding the earth with bayonets or rods. These new mines have concrete bases and sides, and plastic covers, so that the full force of the explosion is directed straight upward.

DETECTORS SPOT THE METAL MINE

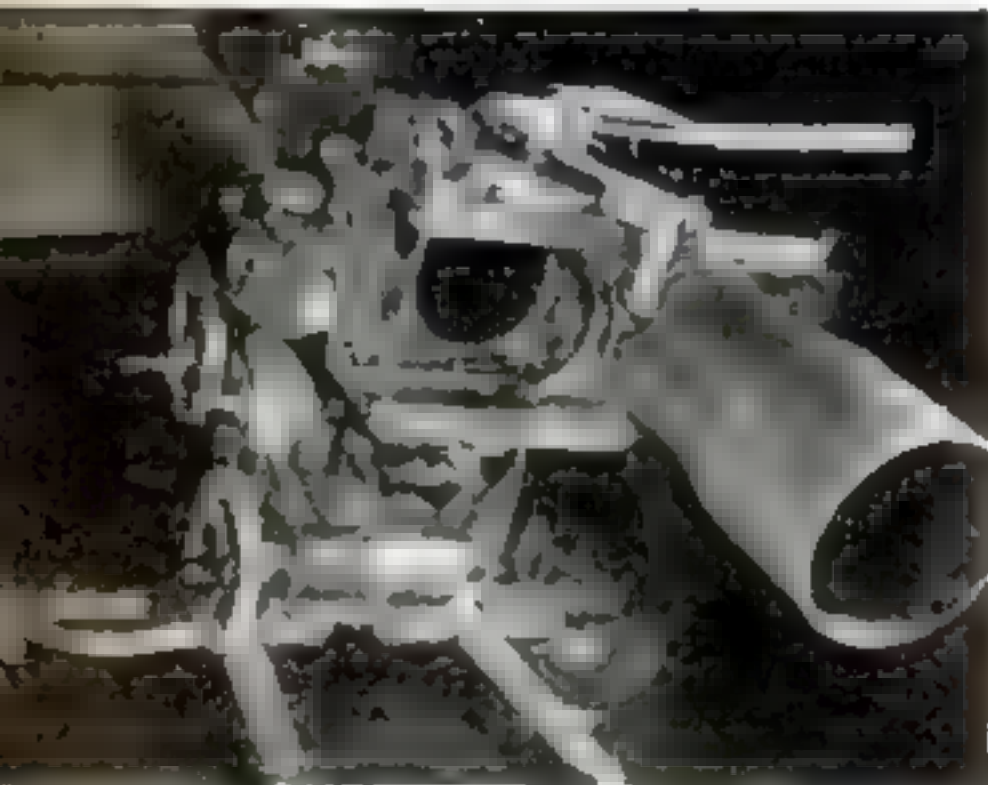
SAPPERS MUST PROBE FOR THE NEW MINE



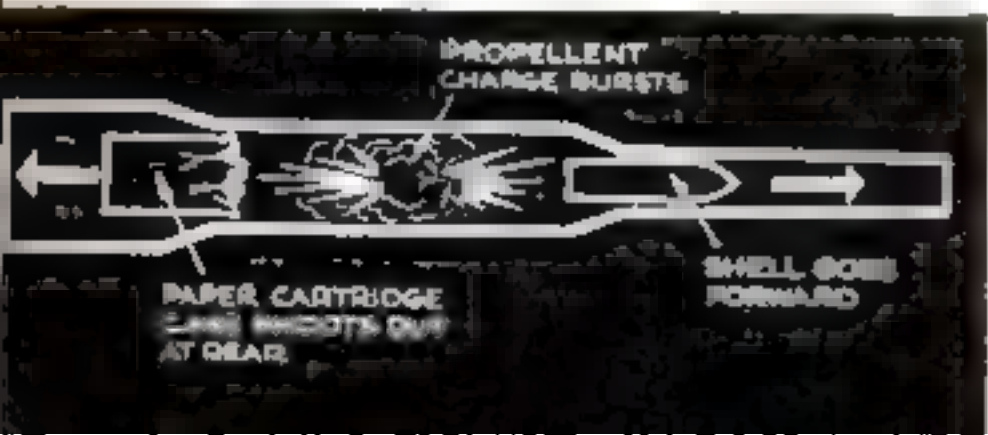


Packing a lusty wallop, this Nazi 75-mm. kickless gun can be dropped by parachute to support advancing infantry. The butt consists of an open tube through which gases can escape to neutralize the backward thrust of the exploding powder charge.

GERMAN armament captured by the Allies reveals that the Nazis are now using a kickless 75-mm. gun that can be dropped by parachute and quickly brought into position in support of advancing infantry. In place of the heavy spring mechanisms or hydraulic cylinders usually employed to cushion recoil in guns of this



Operated by a handle atop the block, the breech slides horizontally to permit insertion of the shell. Diagram below shows how gun simultaneously fires two projectiles in opposite directions.



Nazi 75-mm. Paracannon Has No Kick

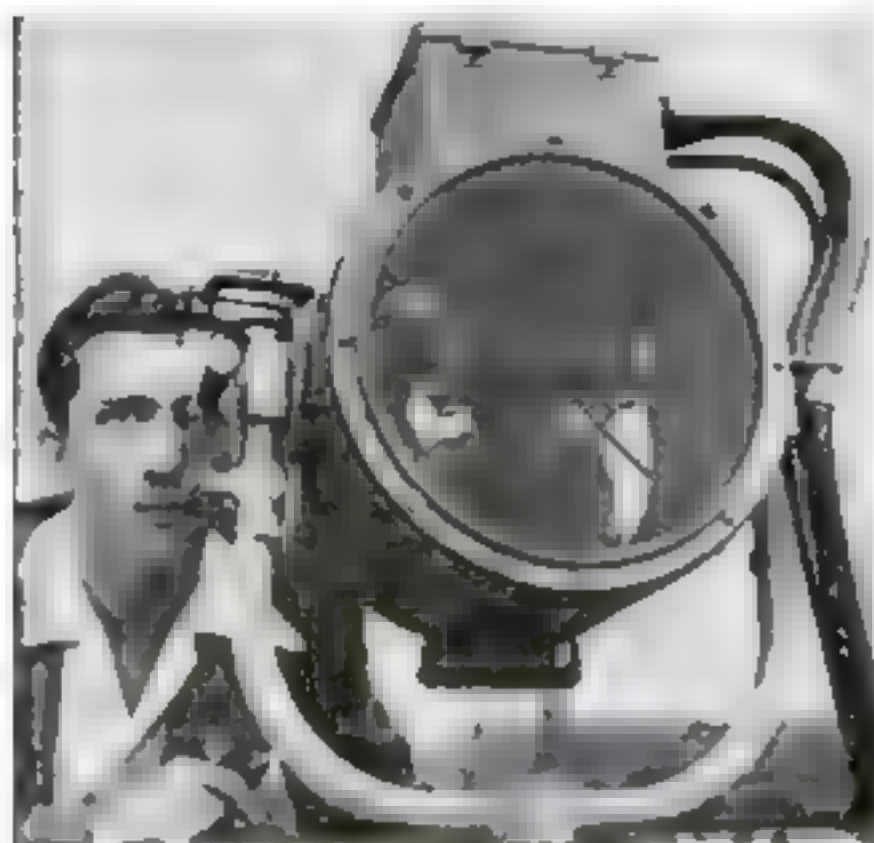
size, this new weapon has a butt consisting of an open tube through which gases can escape to neutralize the backward push of the exploding powder charge. Another novel feature of the gun is that the cartridge case of the shell it throws is made of paper instead of metal. When the gun is fired, this paper case is driven out through the open butt—called a Venturi tube—in the van of the escaping gases. It is this simultaneous firing of two projectiles in opposite directions that solves the problem of recoil.

Believed to have been inspired by a similar Russian weapon, the Nazi gun weighs $225\frac{1}{2}$ pounds, is 45 inches high, and has a six-caliber bore. It is capable of a 42-degree elevation and a 20-degree depression. The Russian recoilless gun, used for the first time in the Russo-Finnish war of 1939, is a 40-mm. weapon weighing 425 pounds and firing a projectile of about $2\frac{1}{2}$ pounds. It is smaller than the German gun, standing only 20 inches high.

The Nazi recoilless gun is patterned after the Davis aerial gun pioneered by the U. S. in the first World War. Dummy load was fired out back end of the gun to neutralize the recoil from the shell. Lewis machine gun helped to get the aim.



TWO CABINS keep waves and weather from the occupants of a new unsinkable lifeboat that embodies in its design the experiences of many survivors of U-boat sinkings. The first of its kind to be built, the boat was recently launched at Delanco, N. J. The 24-foot craft weighs 5,000 pounds, holds 25 persons, and can be driven by motor or sail. The hull can be completely inclosed.



COOL LIGHT "piped" into the interiors of shells through a Du Pont "Lucite" resin rod makes possible safe inspection with this portable lamp used in Canadian shell-filling plants. The rod conducts much of the light but little of the heat from the low-voltage bulb in the special, nonsparking metal handle, providing shadowless illumination. A flexible rubber strip extending from the ceiling swings the lamp out of the way when it is not in use.



FOUR TIMES as powerful as a conventional incandescent searchlight of the same size, a new-type General Electric mercury lamp shoots out a 7,500,000-candlepower blue-green beam. Compressed air under 25 pounds pressure is needed to dissipate the great amount of heat created by the tiny, match-shaped, 900-watt mercury arc that produces the light. Safety switches prevent operation with insufficient cooling air.



SAWED-OFF version of our deadly 105-mm. field-artillery howitzer is the new M-3 howitzer pictured at the left. Comparison with the larger weapon (P.S.M., Nov. '42, p. 54) shows it to have a shortened barrel, compact recoil mechanism, and low-slung carriage. These combine to give it the mobility and low silhouette that would make it easy to man-handle in the field.

Civilians Learn to Drive



OUR driving habits are in for a healthy change. The Army is shaping them to meet the urgent needs of a force on wheels that can be depended upon to get troops and equipment to the right place at the right time. Good driving is a must for soldiers, and the Army has called on our civilian front to produce more driver material. We must learn to drive the Army way.

The Army's new program—the first intensive collaboration between civilians and the armed forces to make better drivers—is primarily for high-school and college students. But it challenges all who drive motor vehicles. It aims to teach prospective soldiers what they have to know to man military transport, and to that end Army driving instructors send jeeps over cross-country courses as civilian passengers hang on and strive to learn how it's done.

Instructors test the reaction of civilian drivers to see how long it takes them to step on the brake when a red light suddenly flashes, and their ability to make smooth, coordinated movements is measured by the way they manipulate special apparatus. Originating in the office of the Quartermaster General in Washington, the program got under way last fall when 115 civilians from 29 states attended courses at Camp

After a ride with soldiers at the wheel, civilians took these jeeps over a winding, bumpy training course. Below, soldiers are demonstrating how to use an improvised hoist to rescue a truck bogged down in a hole.



Cars the Army Way

Lee, Va., and Fort Francis E. Warren, Wyo. They were put through the works for three days, driving jeeps, trucks, and half-tracks over all kinds of terrain, making emergency repairs, learning map-reading and camouflage, and taking notes at lectures covering all other phases of military driving.

These civilians returned to their home states with knowledge that they passed on to educators and motor associations. Today hundreds of high schools throughout the country have added courses in Army driving to their curriculums. Among the subjects stressed are the importance of motor vehicles in America at war; how mechanisms work and what the controls do; how physical and mental factors affect driving; and how to drive in black-outs, dim-outs, and convoys. The responsibilities of civilian and military drivers are emphasized.

Instructors are selected from among teachers. Those who wish to receive special training in the war-time phases of driving find scores of safety centers and motor associations eager to help them. These groups are co-operating closely with the Quartermaster Corps, which supplies instruction manuals containing the latest preinduction training information.—JACK O'BRIEN.

How Good a Driver Are You?

These Army preinduction questions may stump beginners, but not experienced drivers

1. If an approaching driver doesn't dim his lights, need you dim yours? (A) Yes. (B) No.
2. Most auto skids are the result of (A) fate, (B) too much ice, (C) overinflated tires, (D) driving too fast for road condition.
3. Driving down a long hill, the clutch may be disengaged if the shift lever is in high. (A) True. (B) False.
4. Can you slow down as quickly from 60 to 50 m.p.h. as from 40 to 30? (A) Yes. (B) No.
5. Who has the right of way at an intersection with no light or officer when a pedestrian is crossing? (A) You. (B) The pedestrian. (C) You, if you sound your horn.
6. Going downhill, it's permissible to (A) disengage clutch, (B) put car in neutral, (C) use high gear, (D) turn off ignition.
7. The hand signal for slowing is the same as for stopping. (A) True. (B) False.
8. Overinflation of tires increases traction. (A) True. (B) False.
9. A driver might invite a rear collision by stopping too fast. (A) True. (B) False.
10. When skidding on a slippery road, you should (A) use your emergency brake, (B) depress your clutch, (C) steer in the direction the rear end is going.

Answers: (1) A; (2) D; (3) B; (4) B; (5) B; (6) C; (7) A; (8) B; (9) A; (10) C. Nine out of ten correct answers is a good score.

Instant reaction to danger is vital to good driving, so, at left, civilians are tested to see how quickly they can step on a brake when a red light flashes. The apparatus at right reveals how steady they are



Good Valves Give Engines

THESE HARD-WORKING PARTS TAKE A BEATING EVERY TIME YOU

By RALPH ROGERS

EVERY time you drive for one hour at 40 m.p.h. in an eight-cylinder car the 16 valves open and close 840,000 times. Your exhaust valves are exposed momentarily to temperatures as high as 3,800 deg. F. and operate normally at cherry-red heat.

And yet, a dripping faucet, which is also a valve, is apt to get attention more quickly—for you can see the faucet dripping

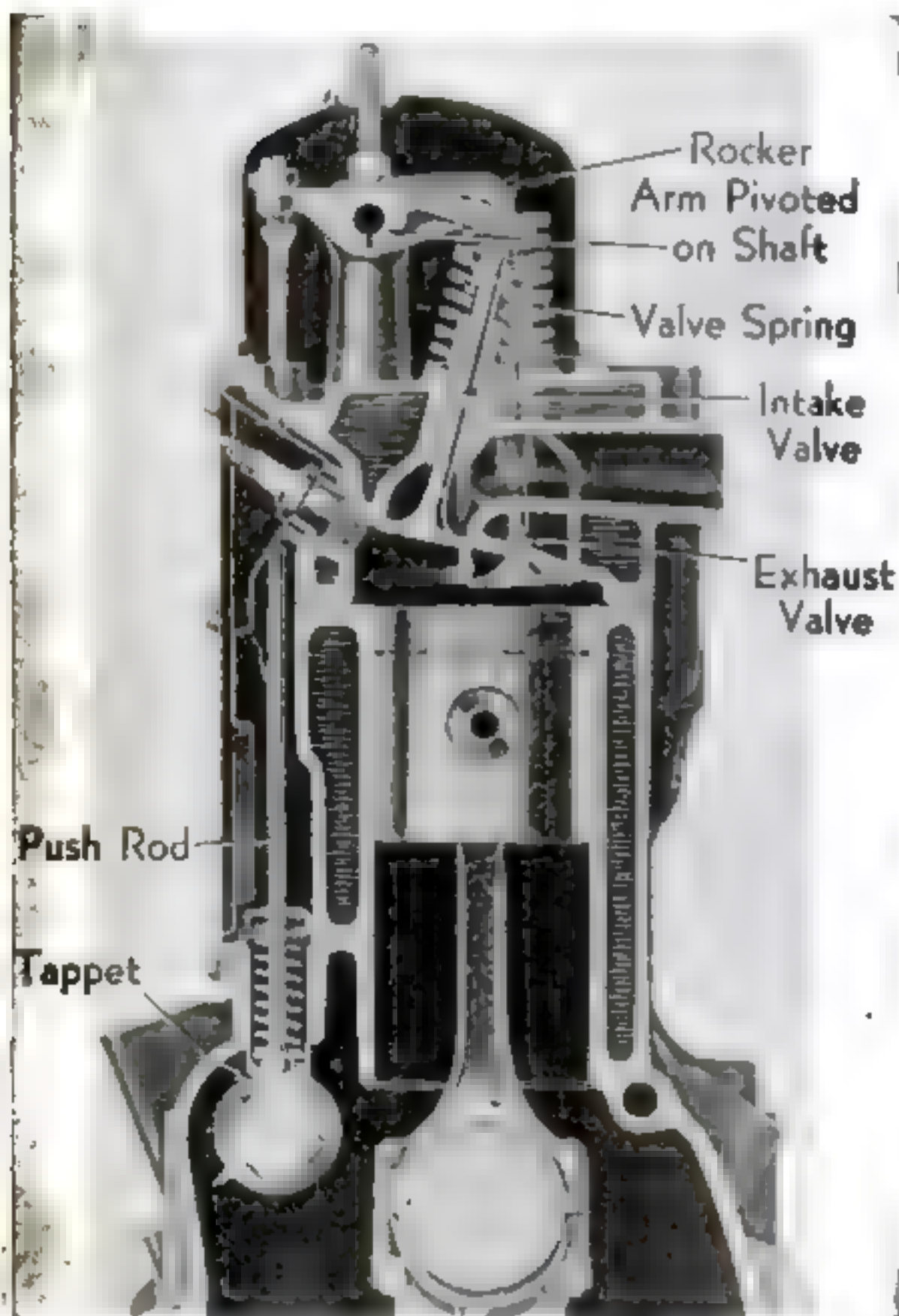
Waste because of pitted valve faces or faulty operation is just as pernicious, but frequently it is not apparent to the automobile owner until his motor begins to run erratically. Serious trouble can often be nipped in the bud, and fuel can be saved, by having your engine "stethoscoped" twice a year by a competent repairman whose shop is equipped with a motor analyzer. If attention should be required then, fewer replacement parts will be necessary if you are warned in time.

You can make a quick check yourself by hand-cranking your engine. Valves that seat fully will hold the fuel charge and cause the crank to bounce back or rock as the engine is turned over. If resistance is lacking on the compression stroke, there is a leak—it can be heard usually as a hiss, and unless this hiss is in the breather, which indicates a leak past the piston and rings, it will mean a faulty valve.

Test with the hand crank on the compression stroke of every cylinder, and if any valves leak, they should be inspected. Punch holes in a piece of cardboard to accommodate the valves as they are removed, numbering the holes so the valves can all be returned to their original openings.

Clean off all carbon and burned oil and examine each valve carefully. Look for pitting and uneven wear on the valve faces, check the stems and their fit in the valve guides, and test the valve springs.

Excessive wear in either the valve stem or guide will make it impossible to obtain a tight seat by grinding unless a new guide is provided. In a very bad case, both the valve and guide may have to be replaced. Too much clearance in an intake guide admits air and oil into the combustion chamber and results in upset carburetion, increased oil consumption, and heavy carbon deposits. Sloppy exhaust-guide clearance causes misalignment and bad valve seating with rapid wear on both the valve and seat. In the absence of the manufacturer's specifications,



Both valves are over the cylinder in an overhead-valve engine, as shown here. On the facing page is an L-head engine valve assembly

Extra Punch

STEP ON THE GAS

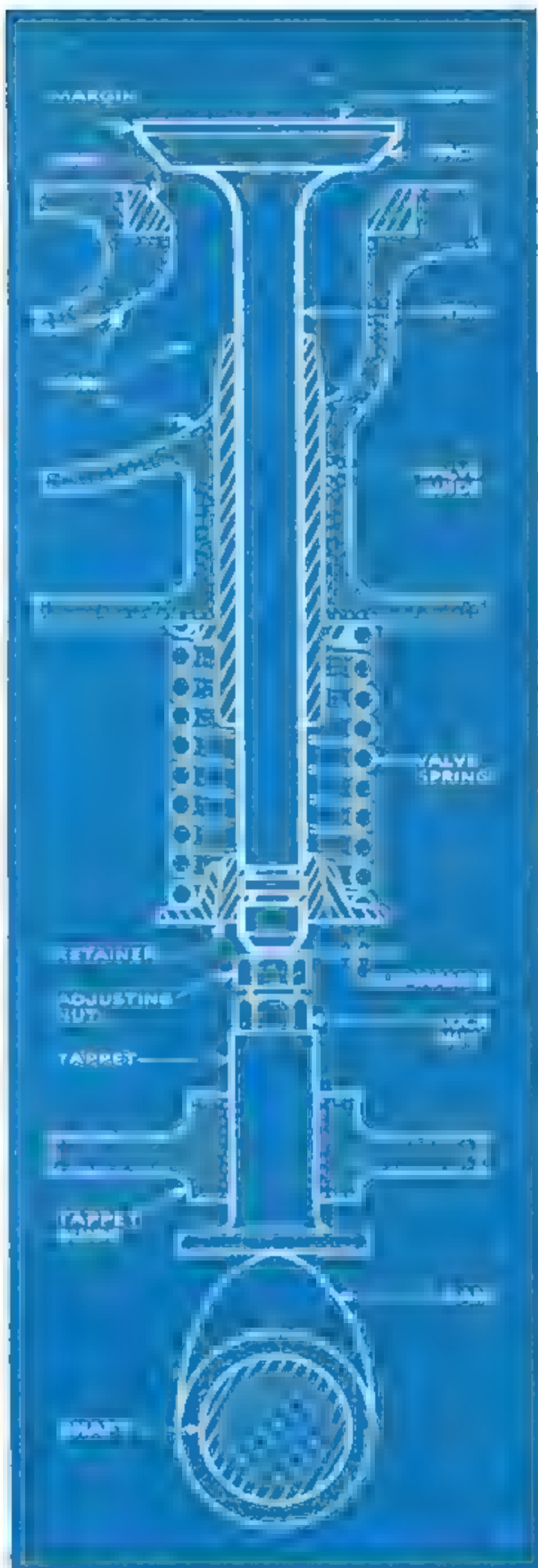
which should be followed exactly if available, replace any guide or valve that produces sidewise movement beyond that which is barely perceptible.

Valve springs should be tested for uniform length and correct tension. If available, a regular valve-spring tester should be used, but fairly accurate results can be had by standing the springs on a level surface and holding a straightedge across the tops to determine irregularity in height. Unequal or cocked valve springs will undo in the assembled job all the good work that has been put into it. Valve-spring tension that is too weak allows a valve to flutter, while tension that is too strong causes what is known as "stretched" valves.

Inlet valves, admitting gas instead of providing an exit for hot flame, do not pit as badly as exhaust valves and rarely need grinding. A valve that leaks compression can usually be ground successfully if it is not burned or warped and if there are no ridges or shoulders on its seat. Burned or warped valves should be refaced with a refacing machine, and ridged seats require reseating with a reseating reamer.

Grinding is done by smearing the face of the valve with a grinding paste or compound and turning the valve back and forth in its seat until the roughness is worn down. This can be accomplished with the aid of a valve grinder—a tool similar to a hand drill, but provided with prongs that fit into the slotted top of a valve or with a suction cup that grips a valve with a smooth top surface. Grinding may also be done by hand, that is, by turning the valve stem.

When grinding, turn the valve back and forth until both valve and seat show a bright ring about $1/32$ " wide all the way around. Clean the valve and seat occasionally when using the hand method to see how the grinding is progressing. It is generally helpful as a guide after the pits have disappeared to clean the valve and seat and to place about eight equally spaced marks with a soft-lead pencil on the valve seat. A quarter turn of the valve





To be ground successfully, valves need a definite margin. A knife edge causes breakage and burning



Use one new spring, if possible, when checking length and tension with the aid of a straightedge



A valve seat should be narrower than the face, for if it is too wide it tends to collect carbon

should then rub each pencil mark. If any marks are untouched, continue grinding.

Be sure to remove all traces of abrasive matter from the valve chamber and ports when the grinding has been completed. Then oil the valve stems and *reassemble each valve in its own opening.*

Some cars have insert rings as seats for exhaust valves. They seldom have to be replaced unless they become loose or are rendered useless by some abnormal engine operation. Loose rings are easy to remove, and others may be cut away with a drill and chisel. Use a bit with a diameter smaller than the width of the insert ring and drill a hole at two opposite sides, being sure not to drill all the way through as this may damage the recess. The undrilled portion can be cut with a chisel so that the ring can be removed in two pieces. A new insert ring should be packed in dry ice for at least 15 minutes before installation so that it will contract enough to be pressed into the recess. If a recess has been worn, an oversize insert can be obtained.

After reassembly, adjust the tappet clearances according to the manufacturer's specifications, which may be stamped on the valve cover plates. Unless directed otherwise by these instructions, warm the engine for about 20 minutes to attain normal operating temperature. Since exhaust-valve clearance is usually greater than intake, you can avoid confusion by adjusting all of one kind first and then the other.

Ford and Mercury adjustments can be made only by grinding the

valve stem. To do this, drop each valve into its opening before assembling the guides and springs, and rest the tappets on the heels of the cams on the camshaft. Slip a feeler gauge between a stem and tappet and, if there is insufficient clearance, remove the valve and grind the end of the stem carefully until the desired clearance is obtained.



Use a valve-spring lifter to compress the spring when removing a spring retainer in an L-head engine. Pincers are needed to grip the retainer to avoid endangering the fingers. Below, a feeler gauge measures the clearance between the tappet and valve stem. The wrenches fit the lock nut and adjustment nuts



Gus Traps an Oil Hog

By MARTIN BUNN

GUS WILSON tore three coupons out of the A book handed to him by a worried-looking young fellow behind the wheel of an apparently well-kept sedan that had paused at the Model Garage gas pump.

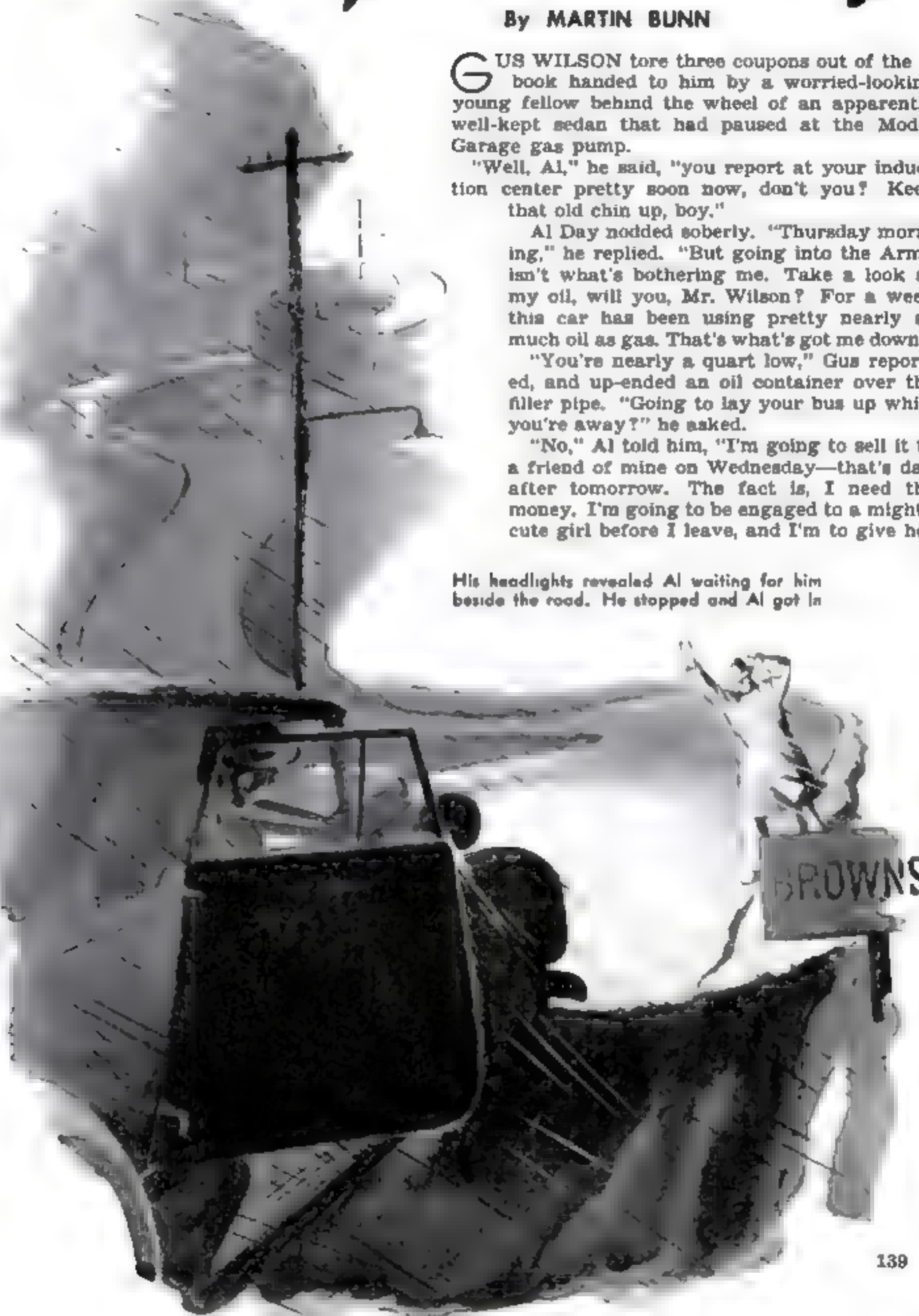
"Well, Al," he said, "you report at your induction center pretty soon now, don't you? Keep that old chin up, boy."

Al Day nodded soberly. "Thursday morning," he replied. "But going into the Army isn't what's bothering me. Take a look at my oil, will you, Mr. Wilson? For a week this car has been using pretty nearly as much oil as gas. That's what's got me down."

"You're nearly a quart low," Gus reported, and up-ended an oil container over the filler pipe. "Going to lay your bus up while you're away?" he asked.

"No," Al told him, "I'm going to sell it to a friend of mine on Wednesday—that's day after tomorrow. The fact is, I need the money. I'm going to be engaged to a mighty cute girl before I leave, and I'm to give her

His headlights revealed Al waiting for him beside the road. He stopped and Al got in



an engagement ring at a party at her house Wednesday night. It's her birthday."

"Congratulations," Gus said, and extended his hand.

"I've paid a deposit on the ring," Al went on, "and I figured to pay the balance with the money I'd get for this car. Now I'm behind the eight ball. The guy who is supposed to buy the car thinks it's in first-class condition, like it was a week ago. Why, I've even just had the tires recapped. It wouldn't be square of me not to tell him something's happened to make it eat up oil. And when I tell him, he'll call off the deal. What can I do, Mr. Wilson?"

"That's easy," Gus reassured him. "It can't be anything serious. Have you noticed any oil on your garage floor recently?"

"No, sir, not a drop," Al said. "I've looked every morning, and I've checked everything else I can think of, too. How about you looking it over, Mr. Wilson? But I'll have to have it back by evening. My girl lives in Brownsville, 10 miles out in the country, and I'm seeing her every night until I leave."

"I've promised a job for tonight," Gus told him, "and I have my hands full tomorrow, too. But suppose you bring your bus back here in the morning and let Stan look it over—Stan's just a grease monkey, but he's learning fast. I'll give him a hand if I can, and if he can't find the trouble, why you bring it back after your date tomorrow night, and I'll tackle it myself."

THE next day when Al drove in, Gus checked the oil again, and shook his head. "You've lost another quart somehow," he said. "How about your oil-pressure gauge?"

"That's how I first found out that something was haywire," Al explained. "One day the gauge didn't show any pressure at all, and a check showed there was hardly any oil left in the crankcase. Since then I've watched the gauge. It's been all right, but I've had to put in a quart of oil every day that I've driven more than a few blocks."

"How about the days you didn't drive more than a few blocks?" Gus demanded.

"Those days it didn't use any oil," Al said. He hesitated for a moment. "Here's something that sounds screwy, Mr. Wilson: the bus uses twice as much oil when I drive out to my girl's house than it does when I drive down to the city and back, but the distance is just about the same. The only difference is that Peggy—that's my girl—lives on the twistiest old road in the State, and the highway to the city is nearly straight. But that doesn't add up to anything, does it?"

Gus laughed. "Not likely," he said.

He turned to Al's car as the youth left. After making sure there were no telltale oil spots beneath the motor, Gus examined

the oil pump on the side of the engine and found it to be in good condition with all connections tight. Then he called Stan Hicks, the Model Garage's current grease monkey, told him what he had learned from Al, and instructed him to make a thorough check.

Stan went over the cap screws securing the lower part of the crankcase. He saw that they were a trifle loose and that there were indications that a little oil had seeped out around them.

"That's the stuff," he told himself. "First thing I look at turns out to be it."

He tightened the cap screws, but remembered Gus's orders and continued his examination. Then he made sure that the valve-cover plate fitted snugly, and that the timing-gear housing was tight. Starting up the engine, he ran it at varying speeds while he listened, but it purred smoothly without knocks that would have indicated a misaligned connecting rod, worn or loose bearings, or loose tappets from which oil might leak. He got out of the car and eyed the exhaust pipe, but no blue smoke, sure sign of excessive oil consumption, came from it. An inspection of the spark plugs showed that they weren't sooty. He put in a quart of oil and looked up Gus.

"It was the first thing I looked at, Mr. Wilson," Stan reported. "But just to make sure, I made a thorough check. The only place oil was leaking was at the cap screws holding the bottom part of the crankcase. They are all right now, and the rest of the oil system is as tight as a drum."

Gus lighted his pipe. "I don't see how a quart of oil a day could have dripped out at the cap screws," he said, "but I suppose that's as likely an explanation as any."

GUS was out when Al came for his car, and there was no word from the youth all day, but at 10 o'clock that evening, just as Gus was ready to go home, the office phone rang. Al was on the wire, and his voice echoed despondency.

"I'm in an awful spot, Mr. Wilson," he said. "I just checked my oil, and the crankcase is practically dry! I'm at my girl's house, and the Brownsville garage is shut for the night. I've got a date at ten tomorrow morning with the guy who's going to buy my car. What had I better do?"

"Keep your shirt on and don't try to drive without any oil," Gus told him. "I'll bring some oil out to you . . . Oh, that's all right, I never get tired. You'll be waiting for me at the edge of town? O. K."

Gus hung up, put a can of oil in his roadster, and started. It was raining hard. A couple of miles out of town he turned off the highway onto the country road—and remembered what Al had said about it being

the twistiest road in the State. But Gus took the turns at an even pace, and within 20 minutes his headlights revealed Al waiting for him beside the road. Gus stopped and Al jumped in.

"Say, Mr. Wilson," he cautioned, "if Peggy's father comes out, don't say anything about my having to sell the car to buy that ring. He's awfully old-fashioned . . . but here we are now."

Al's car was parked under a street light, its front wheels turned sharply into the curb to hold it on the steep grade. A pretty girl in a raincoat got out of the sedan and came toward them when Gus stopped his roadster behind it.

"This is Peggy Milden, Mr. Wilson," Al said.

Peggy smiled mournfully. "Oh, Mr. Wilson," she pleaded, "please get Al's car fixed so he can sell it in the morning."

The import of her entreaty was not lost on Gus. "Don't worry," he said. "It will be sold, all right. That's a promise."

He got his can of oil and began to empty it into the sedan's crankcase. "Why the deuce," he asked himself, "did I say that? I don't know what's the matter with this bus, and the chances are I'll have to buy it myself to make good." Gus is soft-hearted, especially where youngsters are concerned.

When he had filled the crankcase, he turned to Al. "That'll get you to the garage," he said. "I'm going home to bed. Here's the shop key. Drive your car in and leave the key at the diner across the road. I'll get at your job the first thing in the morning."

He smiled at Peggy and got into his roadster. "It'll be all right," he said.

Al Day was waiting in front of the Model Garage when Gus arrived the next morning. In the shop they found Stan scowling at Al's car.

"What's happened to this jalopy since I fixed it?" Stan demanded. "Look how it's leaked all over the floor."

Gus stared at the pool of oil, noticing that the front wheels of the car were cut sharply to one side, just as Al had left them. Without a word, he hurried into his work clothes, told Stan to back the car away from the oil, and crawled under the machine.

"Cut the wheels—sharp," he directed after a few seconds. "That's O. K." He wriggled out from beneath, and instructed Stan to run the car up on the greasing rack.

"I'm losing my grip," Gus told Al. "You gave me a clue when you said your car lost more oil on a twisty road than on a straight one, but I was too dumb to get it. The new recaps on your front tires helped to fool me, too. The wheels are out of line, but you hadn't driven enough on the recaps to make excessive wear show up."

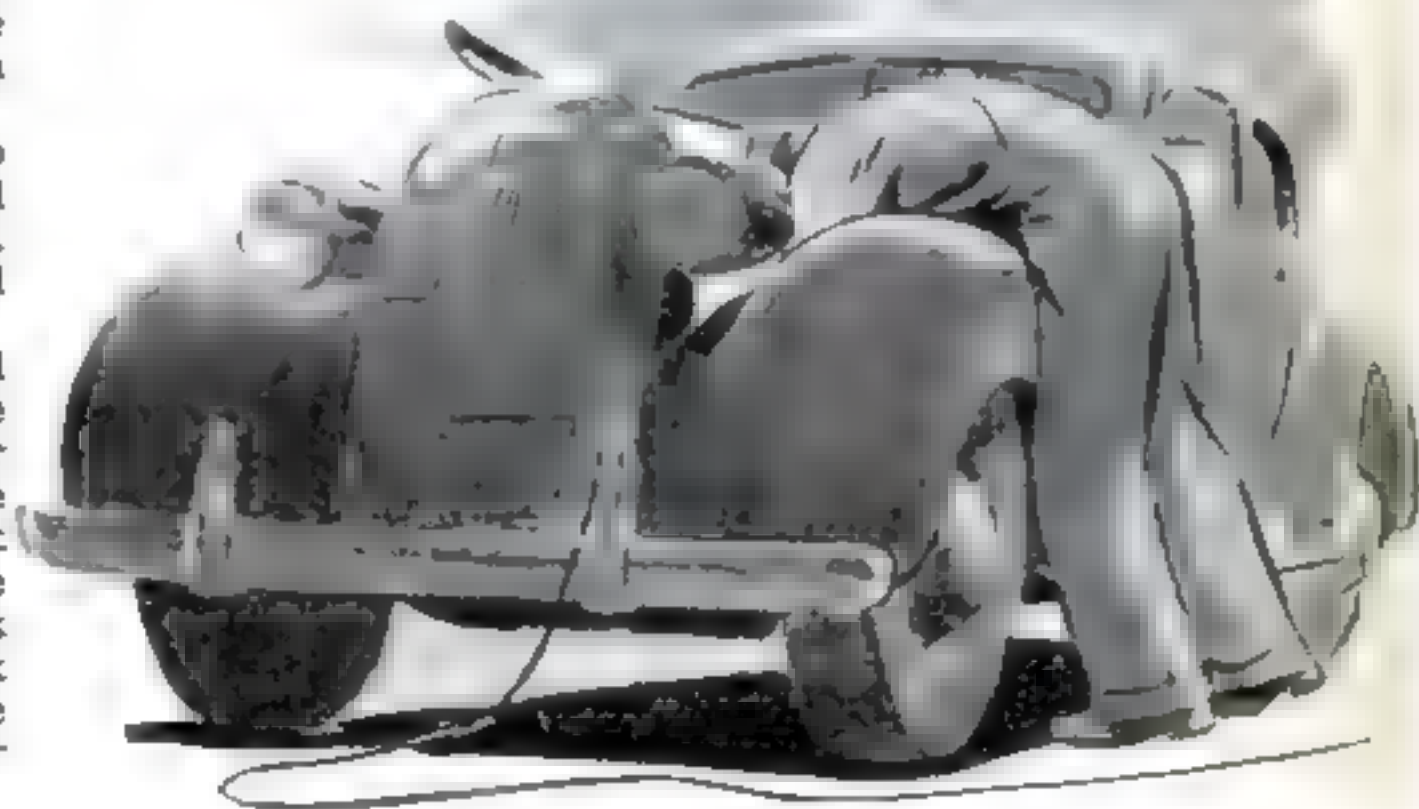
"But, anyway, I've found the trouble now, and it won't take more than half an hour to fix it. Somehow you bent the tie rod. The rod kept rubbing against the front of the oil pan until at last it rubbed a little hole in it, and then the oil dripped out."

Al looked doubtful. "Why didn't the oil drip out when the car was standing in my garage?" he asked.

"For the same reason that your car wasted more oil on a twisty road," Gus said. "When the wheels were straight, the rod was over the hole, so no oil could be lost. But as soon as the wheels were turned either way, the rod moved from the hole and the oil ran out . . . Well, I'll straighten the tie rod and see that the wheels run true again. Then I'll solder a thick piece of shim over the hole, and you can sell the car to your friend with a clear conscience. You can buy Peggy that ring, and you won't have anything to worry about except the war—and I know that doesn't bother you."

"Gee," said Al, "I knew you'd be able to fix it, Mr. Wilson. Thanks a million."

Gus shook his head. "You've lost another quart," he told Al.



HOME AND WORKSHOP

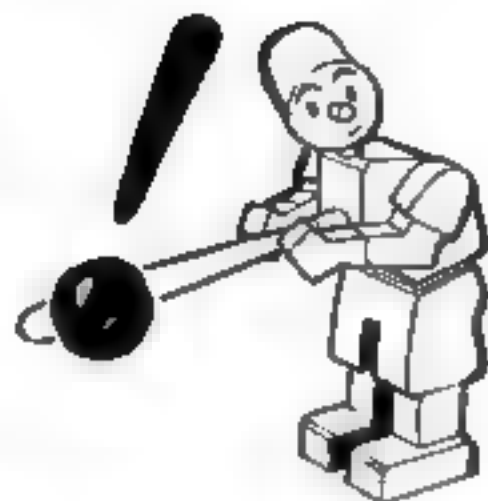


All the plays of real baseball are possible in this colorful table game, which can be built from scrap stock, short pieces of plywood, and a few ends of dowels

PLAY BALL

**A TABLE GAME WITH THE THRILLS
OF BIG LEAGUE BASEBALL**

By Carl W. Bertsch



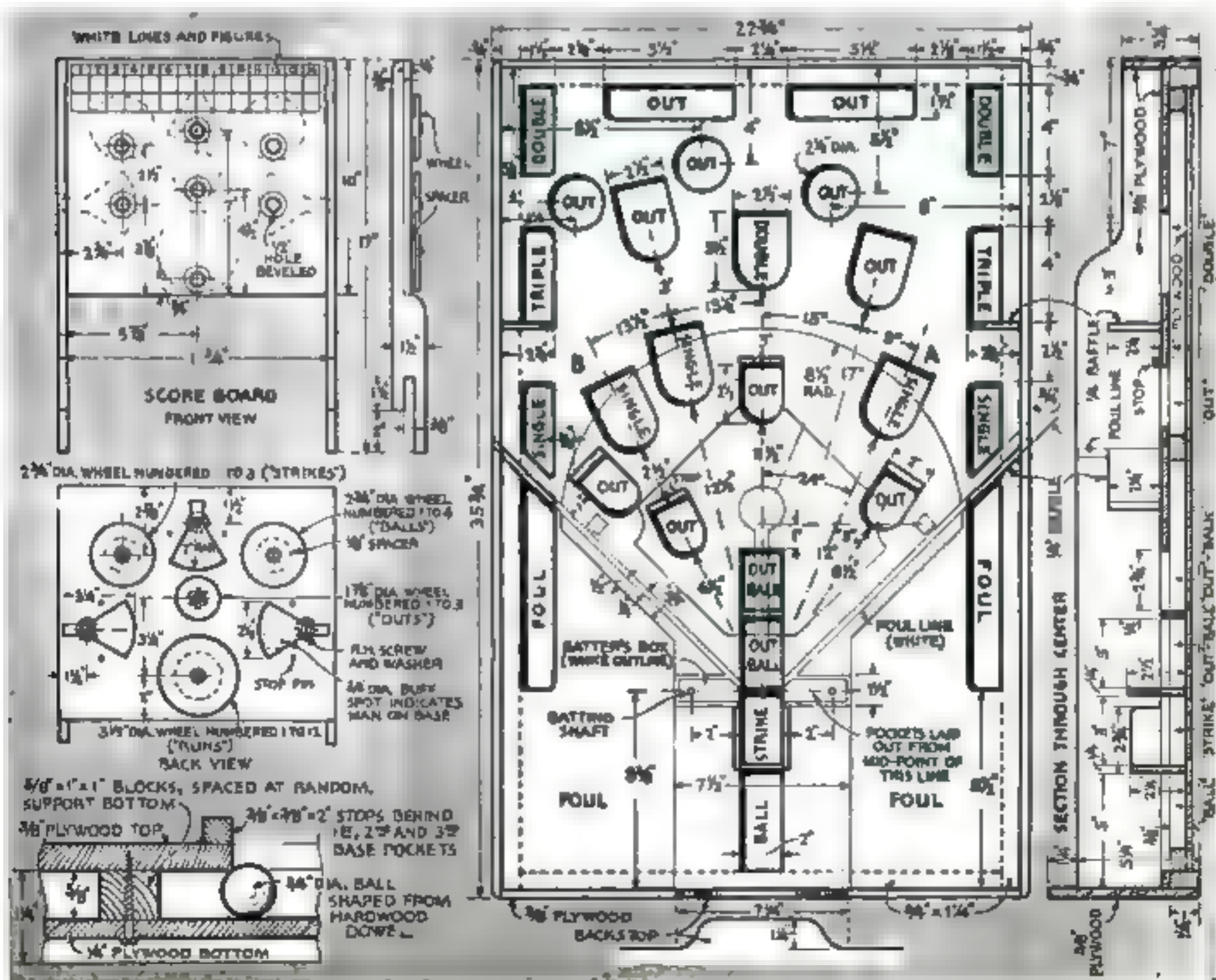
"**B**ATTER UP!" As "Home Run" Joe steps up to the plate, his head cocked toward the pitcher's box, he takes a few tentative swings with his bat. "Strike Out" Kelly, facing him from the mound, winds up slowly. Then comes the call, "Play Ball!" Kelly lets go his delivery, and Joe takes a healthy cut at the horsehide. The game is on!

Just as in a Big League game, anything is possible. For this is a scientifically designed game board with all the plays of a real baseball game and with all the thrills. There is only one difference: the batter is allowed to swing at every offer, and if he fails to connect, the pitch is counted as a ball or a strike depending upon the pocket it lands in at or behind the plate.

Scoring is done as in regulation league

baseball, with three strikes or four balls allowed for each batter, and with three outs for each side constituting an inning. As in baseball also, nine innings make a game, unless there is a tie score at the end of the ninth, in which case extra innings are played until one team wins. An ingenious scoring board behind center field registers the balls and strikes on each batter, the outs on the team at bat, the number of runners on base, and the runs scored in each inning.

A novel feature of the game is the pitching device. The ball is placed in the curved trough at the side of the pitcher, and one of the players swings the movable arm by manipulating the lever. His opponent controls the bat by twirling a dowel that rises out of the back of the batter, who is swung on a fixed pivot in the batter's box. There is



RULES

The ball is in play when the pitching lever is touched.

STRIKES, BALLS, AND FOULS: Scored as marked on the pockets.

BALK: Batter goes to first, but runners advance only if forced.

HITS: Single, double, or triple according to the pocket. Men on base advance one base unless otherwise directed. Over the fence in fair territory on either a fly or a bounce is a home run.

RUNS: Men on second scores on a single by a right-handed batter to pocket A, or by a left-handed batter to B. Men on third scores on any single, when forced in by filled bases, or on a sacrifice fly to one of the "out" pockets at the center-field fence unless it is the third out. All runners advance one base on such a sacrifice.

OUTS AND DOUBLE PLAYS: Batter is out when a ball lands in an "out" pocket except in special cases. When a ball falls into the second-base "out" pocket, a man on first and the batter are both out; if bases are filled, outs are at second and third, man on third scores, batter is safe at first. When a ball falls into the third-base "out" pocket with runners on first and second, the outs are at third and first and a man is safe at second; if bases are filled, outs are at home and third and men are safe at first and second.

one of these pivots on each side of the plate so that the batter may hit either right or left handed. With a few practice tries, players can become expert at both pitching and hitting.

Plywood is used for the most part in the construction of the board, which has a double floor, as shown in the drawing on the preceding page. The upper floor is cut out, as indicated, for holes that form the pockets for hits, outs, and other plays, and is raised off the lower floor by $\frac{1}{2}$ " thick blocks. This leaves enough space between the two floors to trap the $\frac{3}{8}$ " ball when it falls into a pocket, yet not enough to allow

it to roll between the floors where it would be hard to retrieve. Stops behind the in-field "outs" also help to keep the ball from bouncing out and becoming a hit. Baffles make the triples and the singles at the foul line a little harder to get.

The board and figures are shown in full color on page 112 in the rotogravure section. Casein or resin-emulsion waterproof colors in brilliant shades are ideal for painting. Some of the colors used on the original are buff (3 parts raw sienna and 1 part white), light yellow-green (2 parts bright green and 1 part buff), and deep blue-green (2 parts deep blue and 1 part bright green).

RH SCREW AND WASHER

WIRE HOOK
BE AT
T SHAPE

3/8 STOCK
1/4" x 1/4"
BLOCK

CUT BACK

5 REW
TROUGH
EACH LEG

4 SQUARES

SAW CUT

GLUE

MAKE TWO
GLUE
LEFT ARM

BATTER

OUT
BALK

OUT
BALL

STRIKE

HARDWOOD

GLUE
SURF
H SWITS

3/8 DOWEL

ROUGH

NEW
HOLE
PITCHER

2 1/4"

1 1/2"

1 1/2"

1 1/2"

1 1/2"

1 1/2"

1 1/2"

1 1/2"

1 1/2"

1 1/2"

3/8 DIA

HEAD AND NECK
ONE TEE
SHAPE FROM
1 HARDWOOD
DOWEL

TAPE
DO NOT
GLUE

3/8

3/8

3/8

3/8

3/8

3/8

3/8

3/8

3/8

3/8

3/8

3/8

3/8 x 1 1/4"
DOWEL

4 1/2" x 1 1/4"
BLOCK

4 SQUARE

4

8

8

8

8

8

8

8

8

8

8

8

TOP VIEW OF BATTER

Two-Piece REFRESHMENT SERVER . . .

By Joseph Aronson

FINISHED with a limed-oak effect, this two-piece refreshment server combines convenience and usefulness with an appearance handsome enough to make it the envy of your guests. When not required as an extra table, the server is designed so that its folding legs can be stored compactly, and its tray placed over the top of the coffee table described on the following page, saving the latter from the effects of hard use.

The tray shown below was made of $\frac{1}{4}$ " oak plywood rabbeted into solid oak sides. Hand holes were made by boring two 1" holes $1\frac{1}{4}$ " each way from the center of the side rails, and by removing the waste stock between them. All edges were nicely rounded.

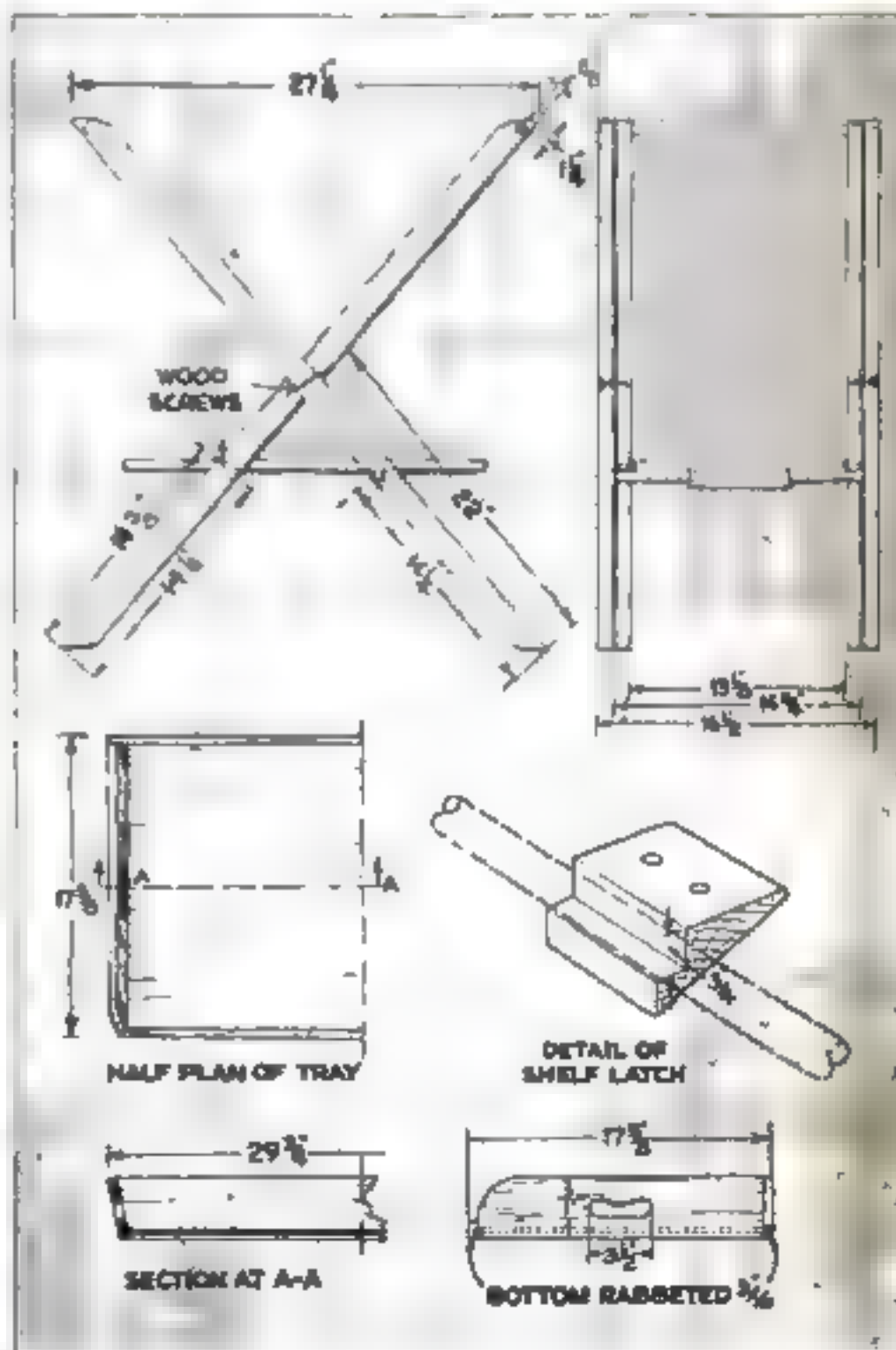
A lower leaf serves both as a shelf and as a stretcher to keep the legs from spreading. It is pivoted on screws between one pair of legs, while to its lower side there is attached a wedge-shaped, rabbeted cleat that engages a dowel between the other pair of legs. The accurate placement of this cleat is important, since it must coincide with the spread permitted by the tray.

LIST OF MATERIALS

TRAY				STAND					
No.	Description	T.	W.	L.	No.	Description	T.	W.	L.
1	Bottom	$\frac{1}{4}$ "	2'	27 $\frac{1}{2}$ "	4	Legs	$\frac{1}{2}$ "	14 $\frac{1}{2}$ "	43"
1	Back rail	$\frac{1}{2}$ "	3"	29 $\frac{1}{2}$ "	2	Dowels	$\frac{1}{2}$ " dia.		14"
2	Side rails	$\frac{1}{2}$ "	3"	18 $\frac{1}{2}$ "	2	Dowels	$\frac{1}{2}$ " dia.		14 $\frac{1}{2}$ "
1	Front molding	$\frac{1}{4}$ "	1"	28 $\frac{1}{2}$ "	1	Shelf	$\frac{1}{2}$ "	12"	32"
					1	Cleat	$\frac{1}{4}$ "	2"	6"

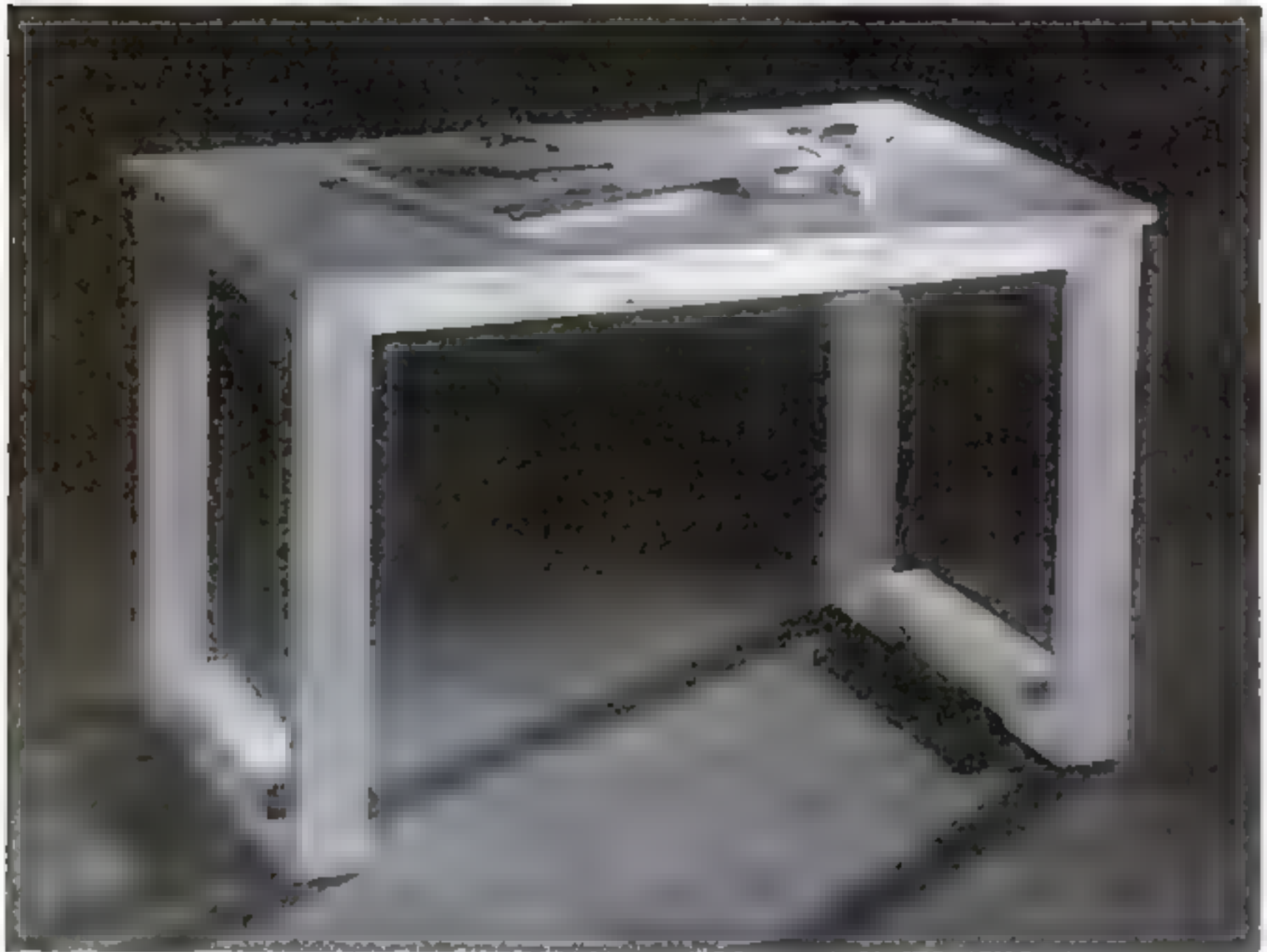
Note: All dimensions are given in inches.

Note: All dimensions are given in inches.



Simple COFFEE TABLE

Has Smart Modern Lines

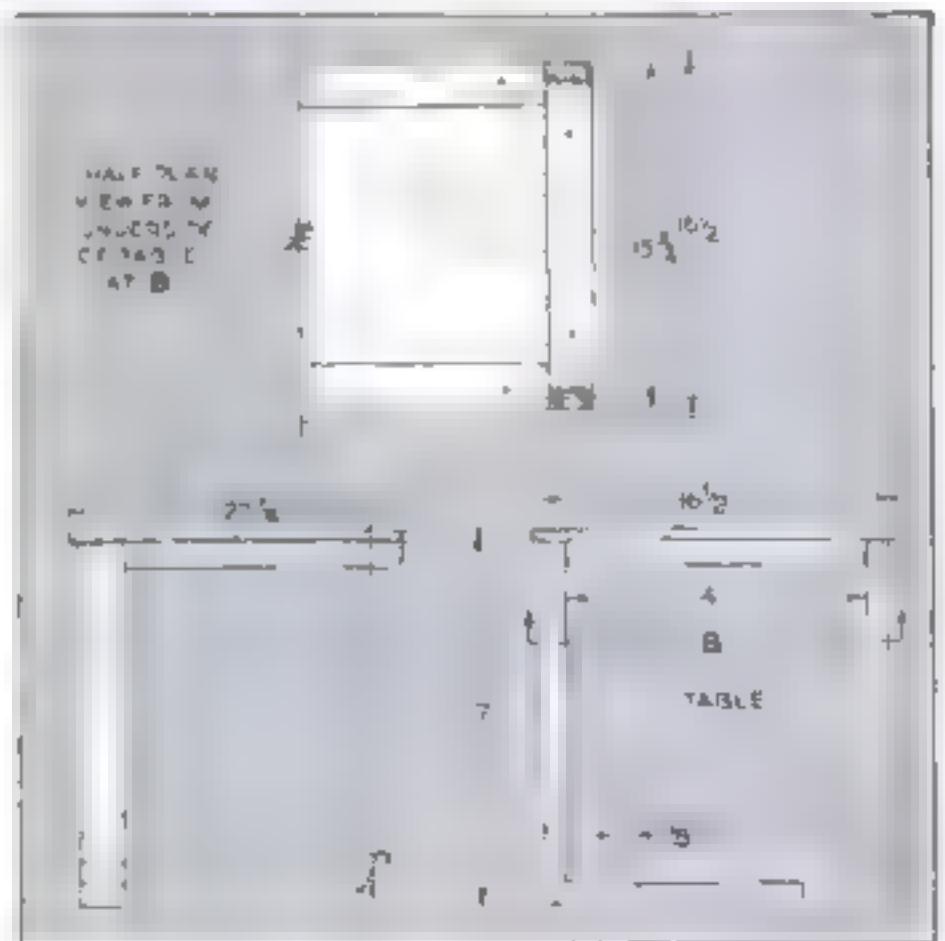


NOVELTY and design of real merit are combined in this coffee table that, like the informal serving stand on the preceding page, is given the appearance of limed oak by applying a paste filler to which white pigment has been added.

Although the table is intended to be used independently, its top is proportioned so that the tray of the serving stand will fit exactly upon it. Guests can thus be served without transferring dishes from the tray.

The two low-placed stretchers between the table legs are assembled from short pieces in a shape that contributes to the modern feeling of the whole table. Cut from solid $\frac{3}{8}$ " oak, the top is screwed fast to the 2" face side of the aprons, leaving recesses at each corner just large enough to accommodate the legs. The legs are then attached by doweling and gluing them securely to the end aprons.

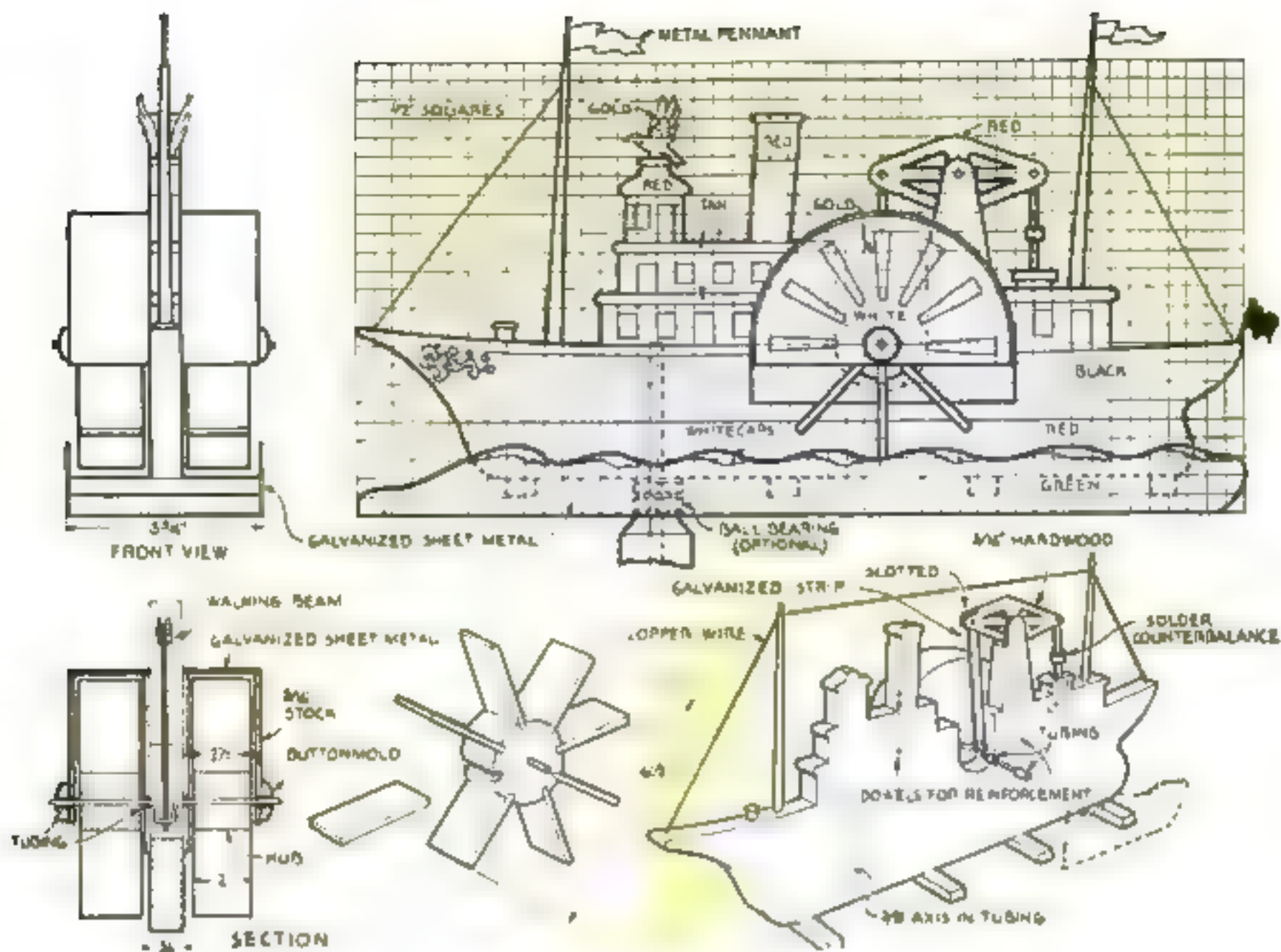
Apply the filler to the wood and rub against the grain with a clean cloth until paste remains only in the depressions. The limed effect can be preserved with a thin coat of flat varnish, which can be rubbed to a satin finish.—JOSEPH ARONSON.



LIST OF MATERIALS

No. Pt.	Description	T.	W.	L.	No. Pt.	Description	T.	W.	L.
1	Top	$\frac{3}{8}$	16 $\frac{1}{2}$	27 $\frac{1}{2}$	2	End aprons	1 $\frac{1}{2}$	2	14
4	Legs	$\frac{3}{8}$	2	15 $\frac{1}{2}$	4	Stretcher pieces	$\frac{3}{8}$	2	8
2	Side aprons	1 $\frac{1}{2}$	2	22 $\frac{1}{2}$	3	Stretcher pieces	$\frac{3}{8}$	2	10 $\frac{1}{4}$

Note: All dimensions are given in inches.



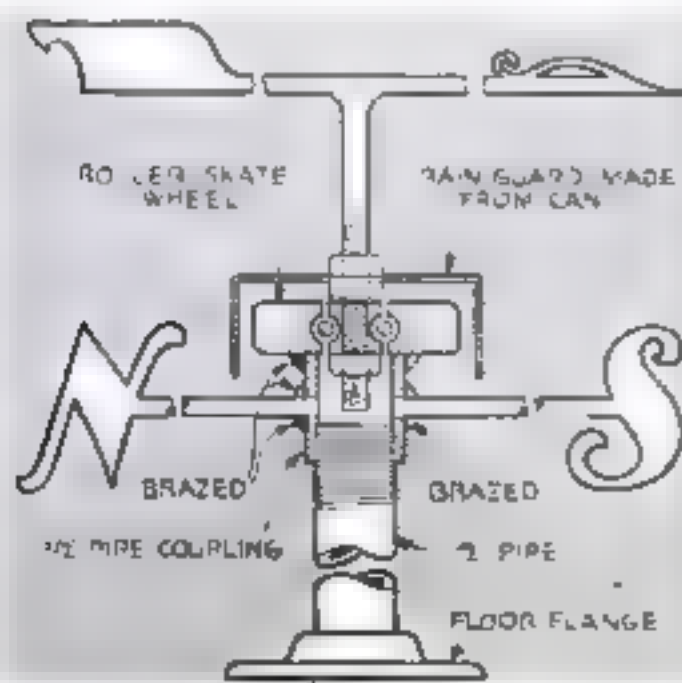
SIDEWHEELER WEATHER VANE

Breeze Gives Realistic Motion to Its Paddles and Walking Beam

AS THE vessel turns with the wind, the paddle wheels of this steamer supply power enough to cause the walking beam to oscillate in even a moderate breeze. Painted as indicated, the little boat is an effective outdoor ornament.

Except for paddle wheels and boxes, walking beam, masts, and capstan, the entire ship is silhouetted in $\frac{1}{8}$ " pine cut from a 10" board. Dowels are inserted in the stack and walking-beam standard to prevent warping. The paddle wheels are a push fit on a wire crankshaft that turns in short sections of

small tubing, preferably of brass or bronze. Similar short lengths of tubing may also be placed in the three bearings of the walking beam. The paddle wheels will rotate freely and smoothly if the crankshaft is counter-balanced with a lump of solder on the aft connecting rod. Small oil holes packed with cotton in the crankshaft bearings will increase the efficiency. Crosspieces nailed under the keel support strips of tin cut and painted to resemble waves on each side of the ship. The entire unit is carried on a ball-thrust bearing.—HI SIBLEY.



Skate Wheel Forms Vane Mount

WHEN fitted with an axle and mounted on a standard, as in the drawing at left, an ordinary ball-bearing roller skate wheel will serve as a weather-vane mount that will turn silently in the slightest breeze. The shaft on which the vane pivots can be a skate axle or any $\frac{1}{4}$ " steel rod threaded and held in the bearing with nuts. Pack the bearing with grease and protect it from rain with the bottom part of a tin can inverted and held as shown.—RICHARD VERBRUGGHE.

MANY a model railroad is a small replica of its big brothers, with rolling stock carefully scaled and conscientiously built—only to travel a roadbed which is laid upon a terrain quite as monotonous and barren as a desert, and far less real. Yet this need not be the case. Even though easy accessibility to the tracks is paramount in a model railroad layout, much can still be accomplished in the way of imitating nature along the pike.

The first step, and a highly important one, is to justify the layout—to devise the geological and geographical reasons that seem to make your particular track layout necessary. (See P S.M., May, 1943, p. HW 166.)

Once you have determined upon the topographical and other features you wish to use, you must then study carefully the way such details appear in nature. In fact, it will be helpful to take a leaf from the diorama builder and to collect a file of special photographs culled from magazines. Keep them in envelopes or folders under such headings as: Highways; Farmland; Flat Country; Rolling Country; Mountains; Streams, Rivers, and Lakes; Trees and Foliage; Villages and Towns. Such photographs will aid you in creating a miniature countryside that will be far more realistic than one designed from observation alone.

The task of transforming the bare wood upon which your tracks are built into a convincing imitation of nature requires a highly versatile covering material. It should be easy to prepare and manipulate, adapted to following undulating contours, and capable of suggesting the texture of earth, rocks, concrete, masonry, bricks, and many other surfaces. Perhaps this seems a big order, but "asbestos maché," a handy and useful

Nature in

material for the modeler, can fill the bill.

By following the formula illustrated on page 150, you can make this modeling compound, which is light, fire resistant, simple to apply, and needs no further preparation before painting. It keeps plastic for more than a month if wrapped in damp cloths. It adheres firmly to nonporous surfaces, and it dries hard in a day or two if applied in a well-ventilated room. It is not waterproof,



1 A commonplace scene along a macadam road in the country is picked for duplication in miniature. The finished job appears next month

2 A wooden framework that has the chief contours of the land is made, after which some wire screening is nailed or stapled in position

3 Asbestos modeling compound is made up and applied thinly upon the frame. This surface is then shaped with the four tools shown



Miniature

The scale of this model, made by the writer, may be gauged by its 4' depth. The figure is about 1 1/4" tall, while the corn shacks in the foreground are 2" high. Flowing water fills the trout stream

... FOR YOUR MODEL RAILROAD

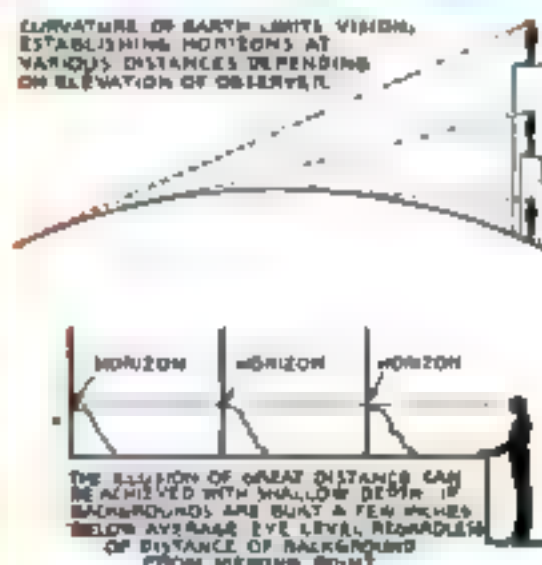
though, and will soften if soaked. The asbestos cement and whiting can probably be obtained at a hardware store, the yellow corn dextrin at a paint store, and the sulphonated castor oil at a druggist's.

After you have decided upon the terrain and features you wish to duplicate, the next

step is to build a framework which roughly follows the contours needed. Ordinary window screening, stapled to wooden supports, will serve nicely. With elevations up to about 10", the supports may be jigsawed from odd pieces of solid lumber, although with greater heights a light, braced frame-



CURVATURE OF EARTH LIMITS VISION, ESTABLISHING HORIZONS AT VARIOUS DISTANCES DEPENDING ON ELEVATION OF OBSERVER.



THE ILLUSION OF GREAT DISTANCE CAN BE ACHIEVED WITH SHALLOW DEPTH IF BACKGROUNDS ARE BUILT A FEW INCHES BELOW AVERAGE EYE LEVEL, REGARDLESS OF DISTANCE OF BACKGROUND FROM VIEWING POINT.

The laws of perspective are of great value in making a layout that will simulate nature. But experiment to be sure that the correct illusions are created



Photo courtesy New York Central System

Collecting photos that show details of railroad landscapes will help you to achieve a convincing realism

work is more satisfactory. For best results, large flat wooden surfaces should also be covered with screening. However, if the wood is first scored with a sharp tool and then well covered with shellac or clear lacquer, the mix will normally adhere without screening. Where a slope bends with a horizontal surface, be sure at least to carry the screening well beyond the juncture to provide a good bond.

In applying the asbestos mix, use thumb and fingers to spread a thin coat (about $1/16$ " thick) on the screening, using an even thinner coat on unscreened surfaces. Since the modeling compound adheres firmly to itself, you may build up and model the terrain as thickly as needed on the undercoat.

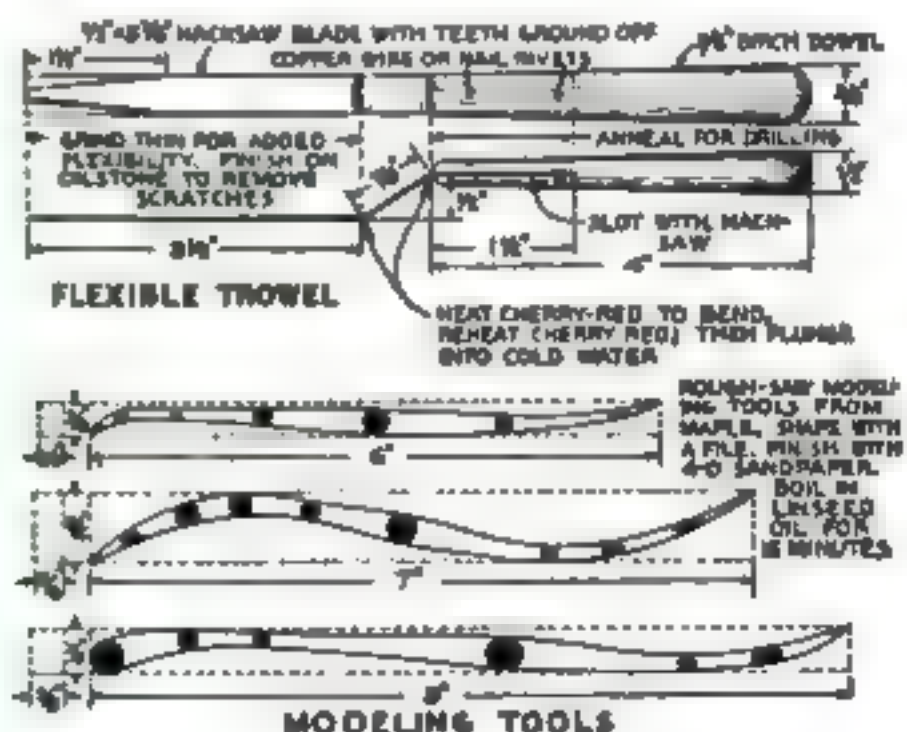
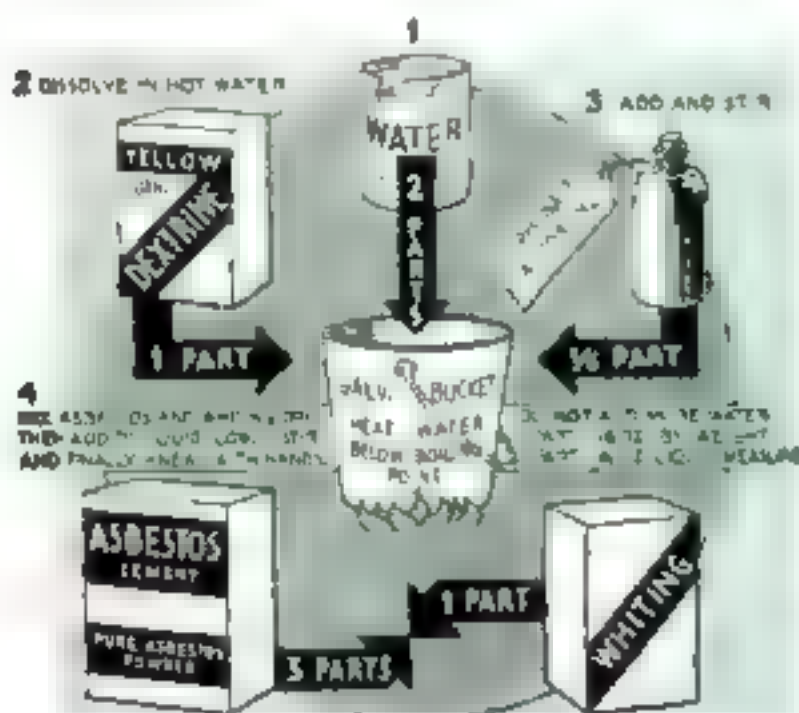
A variety of effects can be achieved by using your fingers alone to produce the curves and contours of land. For paved roads, sidewalks, concrete, brick, rutted roads, masonry, and so forth, use the flexible trowel and modeling tools illustrated. A piece of sponge rubber will also prove handy. Wet the tools and your hands occasionally to keep the mix from sticking.

For gravel, sprinkle coarse, clean sand on the wet modeling compound and press it in lightly. Small pebbles will do for water-smoothed stones, while large boulders and

outcropping formations may be simulated by appropriately sized rocks. In creating rock formations, first work a thin coat of the mix onto the underside and other contacting surfaces, and then build up the "earth" as needed, even to develop a quarry or cliff.

The model railroader who strives to add realism to his pike must deal with knotty problems of perspective in presenting a natural scene with relatively shallow depth. Wherever rolling stock moves without much variation from table-top level, perspective cannot be perfectly achieved, because the locomotives and their cars won't "diminish." From a purely theoretical standpoint, the most nearly ideal layout would be to have three separate track systems, with O-gauge in the foreground, OO-gauge in the middle-ground and at a higher level, and HO-gauge for the distance and a still higher level. A drawing on the preceding page illustrates the way perspective angles change according to the height of the observer's eyes above ground. Note that if you have a pike in which the background is nearly up to eye level, you can sometimes achieve an effective illusion of distance.

A second article, to appear in an early issue, will discuss the modeling of trees and foliage.—CARL W. BERTSCH.



HANDMADE DOVETAILS

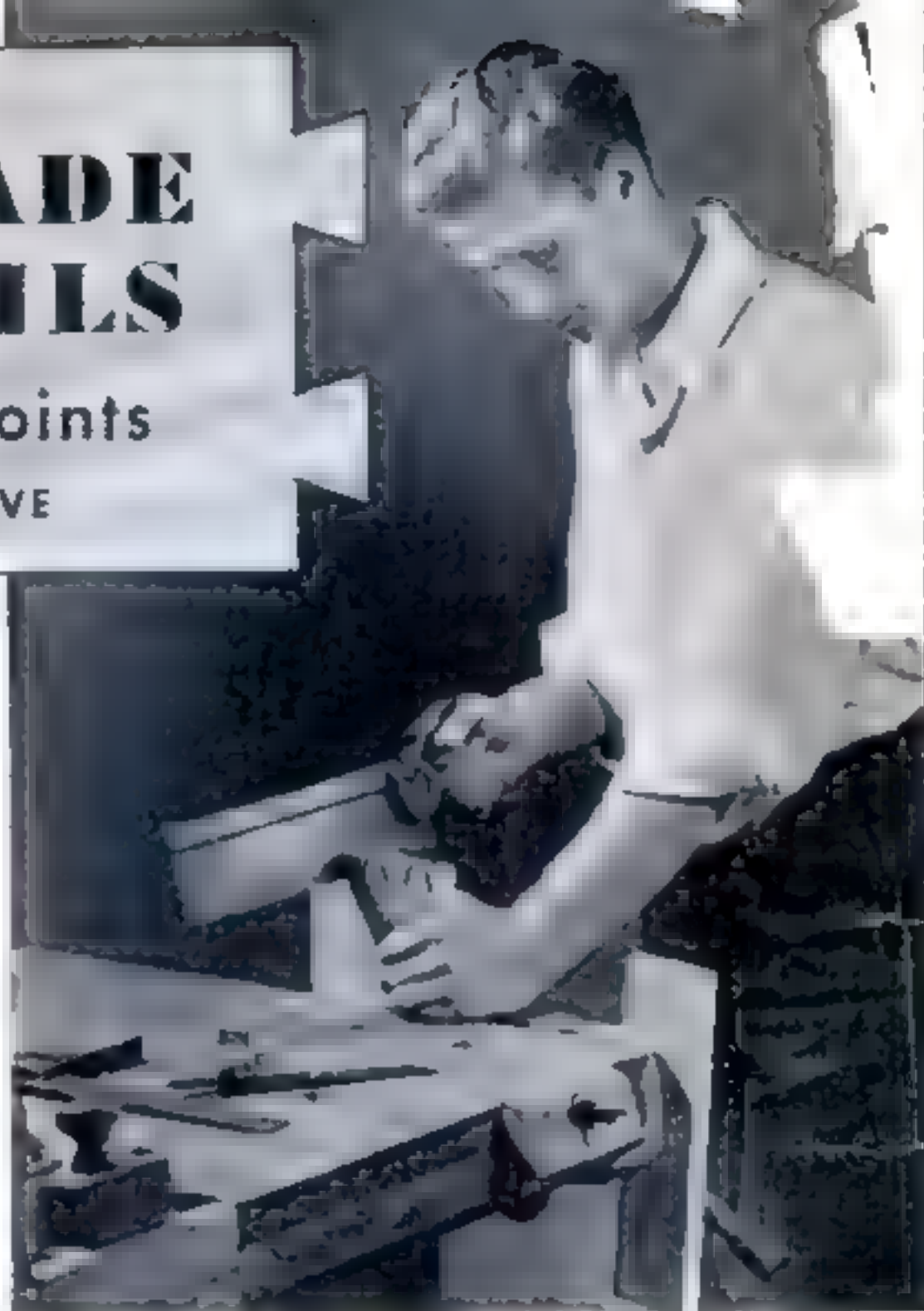
Form Strong Joints

By EDWIN M. LOVE

DOVETAIL joints, well known for their strength, have long been used in fine cabinet work. Nowadays they are frequently displaced by other types of joints that are easier to make with power tools, but where a self-locking joint is needed for use without glue, the dovetail is unsurpassed.

What are typical uses for dovetailing? The most common is the lap dovetail used for attaching the sides of a drawer to the front. Single through dovetails are excellent for such jobs as edging workbench tops, or for joining cabinet stiles with an upper drawer rail. Multiple dovetails make rugged corners on boxes to be veneered. Where extra neatness is desired, substitute a stopped-lap dovetail for the plain lap, and for the finest effect employ a secret dovetail, which resembles a mitered joint but does not forfeit necessary strength.

How is a single through dovetail made? True the material and mark a working face



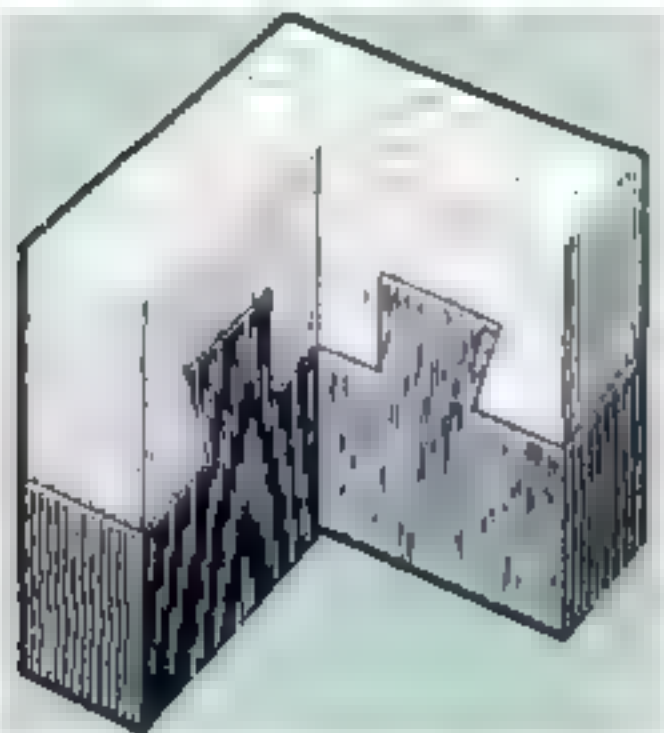
Dovetails and pins are sawed along the sides with a back-saw, or a rip saw for large work. The guide lines are split and the blade kept in waste wood for precision in fitting

and edge with penciled crosses. When laying out the joint, it is well to add $1/16$ " in length to make the pins and tails project upon assembling. These projections are dressed flush after the glue is dry. Square pencil lines around the pieces to guide in cutting the sockets, and square another line midway between the line on the face of the tail member and the dovetail end. This line is not indispensable, but it is a most convenient base on which to proportion the tails and pins. By making the tail four tenths of the width of the piece along the base line, a strong joint is assured. A bevel square set for a slope of 1" in 6" may be used in marking the sides of the tail.

Clamp the piece in a vise for sawing the sides of the dovetail. Keep the kerf in the waste material and split the lines. A back-saw (or for small work a dovetail saw) is best to use, since the blade is stiff. For large work a rip saw will prove satisfactory. Saw the shoulders last.

Use the dovetailed piece as a template for scribing the guide lines on the end of the

CAN THIS JOINT BE MADE?



Two dovetails at right angles on the same piece of wood look impossible to assemble. How's it done? The answer is on page 153



The board above is being divided into equal parts for dovetails by inclining a scale to include the necessary number of intervals between the edges



Sockets should be chiseled half through from one side and finished from the other. Usually it is not necessary to clamp the material to the bench

Trace around the dovetails with a hard pencil to outline the ends of the pins. Align the pieces accurately and hold the dovetailed part rigidly

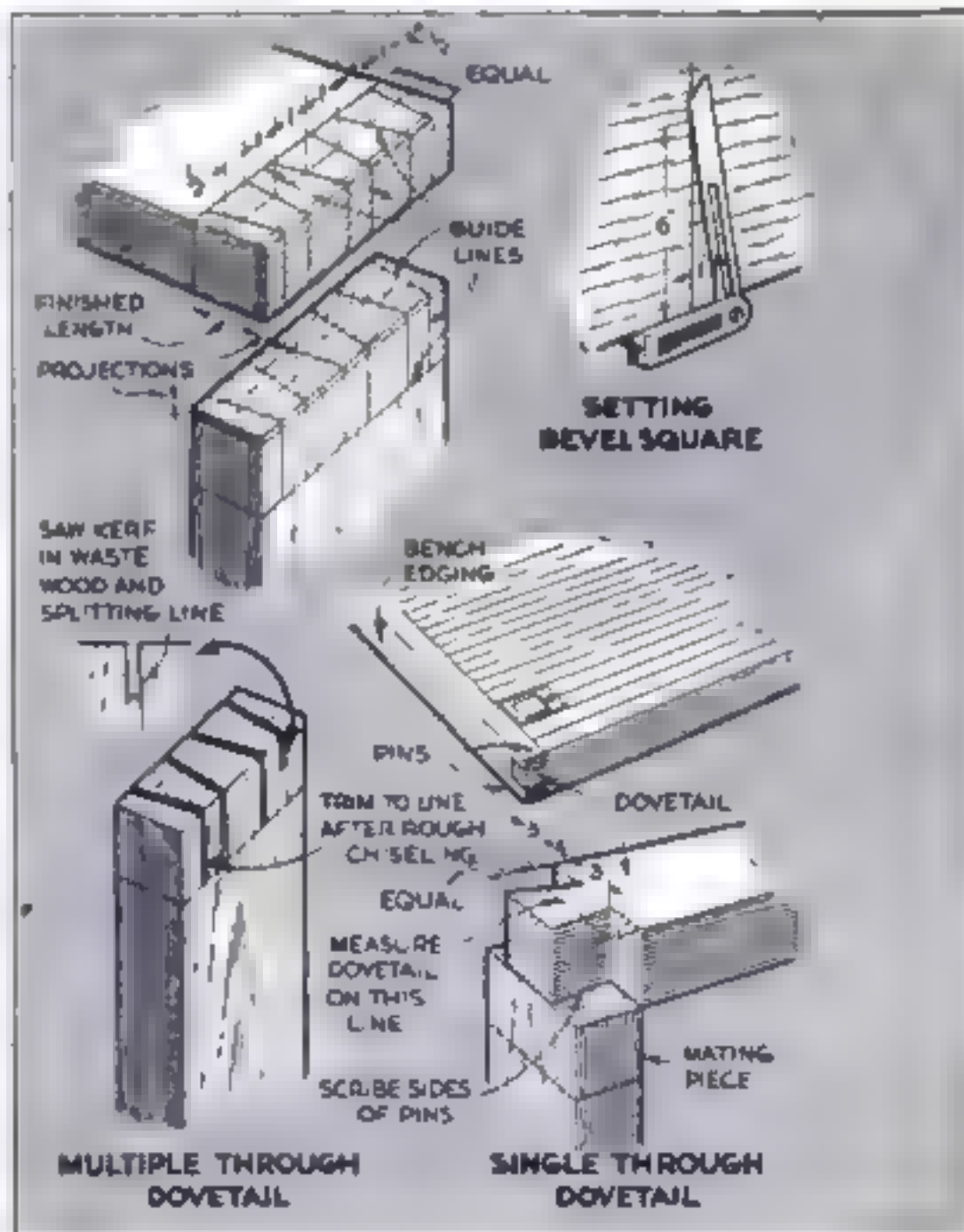


mating piece. Gauge lines on the faces of the stock for the pin sides, or square them down if the ends are square. Rip the sides and chisel out the sockets, working half through from one face and then cutting from the other.

Are multiple through dovetails the same? The routine is similar. Plan for half pins or half dovetails at the edges, and proportion the tails and pins about equally. Some craftsmen prefer to make the tails very wide and the pins quite thin, which varies the spacing and reduces the number of sides to be cut. As with the single dovetail, the midway base line and the bevel square are helpful in laying out the joint. If a half division is used at the beginning and end, the spacing of dovetails will be correct. A proficient woodworker can use a rule and estimate the inclination of the tail sides.

In making more than one joint, time is saved by clamping dovetail pieces together, laying them out, and cutting the sides as one piece. Lines drawn across the face will guide in chiseling the mortises. Smooth socket bottoms can be cut with a coping saw.

What are half-lap dovetails? Plan the side members to mesh into two thirds or three quarters of the thickness of the joining part, and scribe the dovetails on the end wood of the other piece, as with through joints. The mortises are chiseled, except that



the sides can be glued diagonally about halfway to the opposite corners, as shown in the drawings. In drawer construction it is usual to make half pins at the top and bottom of the front. The dovetails must be proportioned so as to bring one over the edge of the drawer bottom, where it will hide the end of the groove in the front piece. Sometimes the top and bottom tails are made narrower than the rest, an easy expedient when the width of the board does not divide evenly.

How is a stopped dovetail made? The dovetails are not cut through the thickness of the sides, as in the lapped joint, but are chiseled from the inside so that the ends of the pins are hidden upon assembly. Cut the pins first, and trace around the ends on the inner faces of the side pieces.

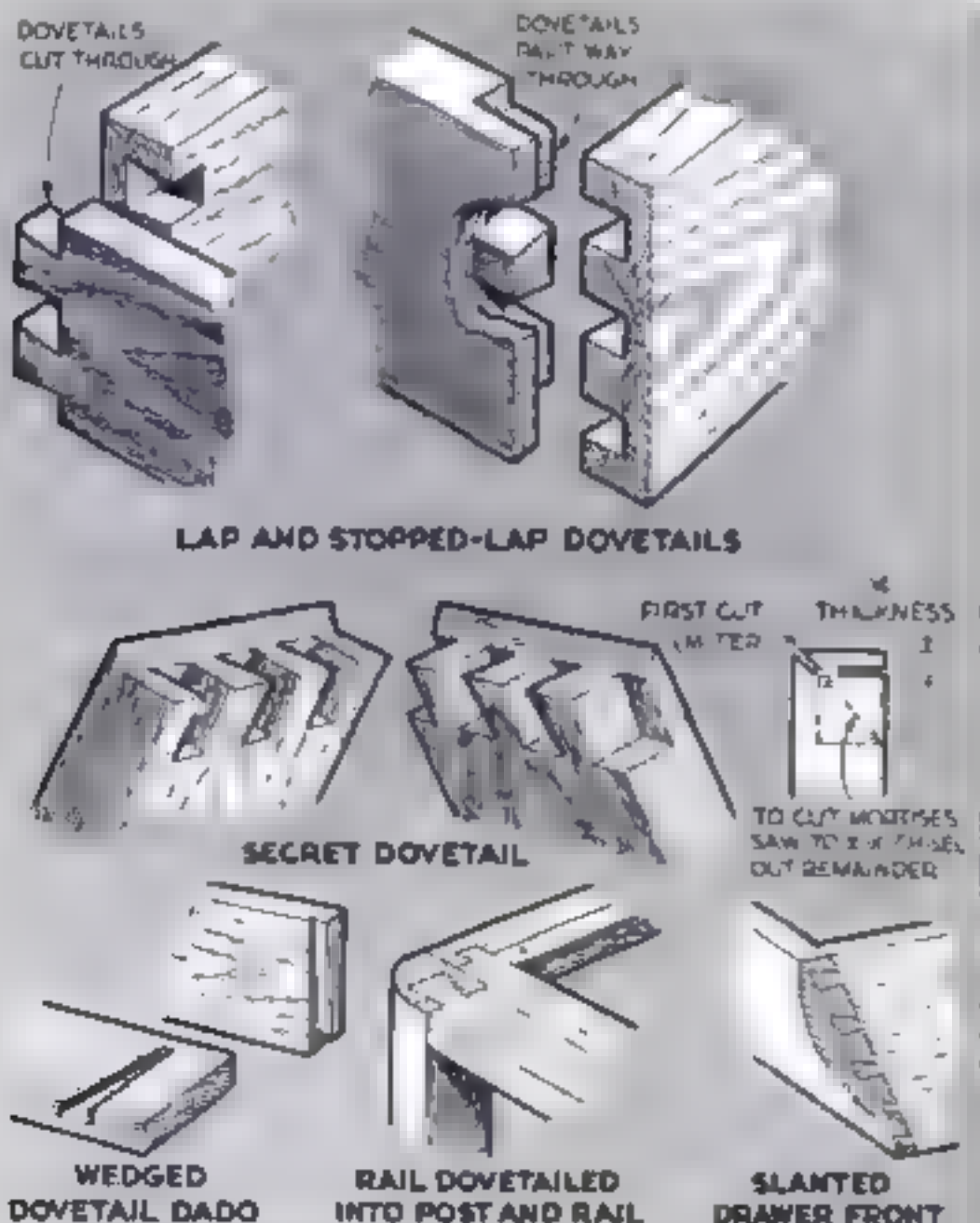
What is secret dovetailing? First saw a miter from the outer arris of each mating piece, and cut back the ends to a distance equal to one fourth of the thickness of the stock. In these shoulders cut sockets the same way as they are cut in making the stopped-lap dovetail.

How are rails and shelves dovetailed? For a rail, work dovetails and scribe around them on the upper ends of the stiles or posts. In some cases a wider rail can be used, with extra dovetails allowed to tie into the upper edges of the side rails.



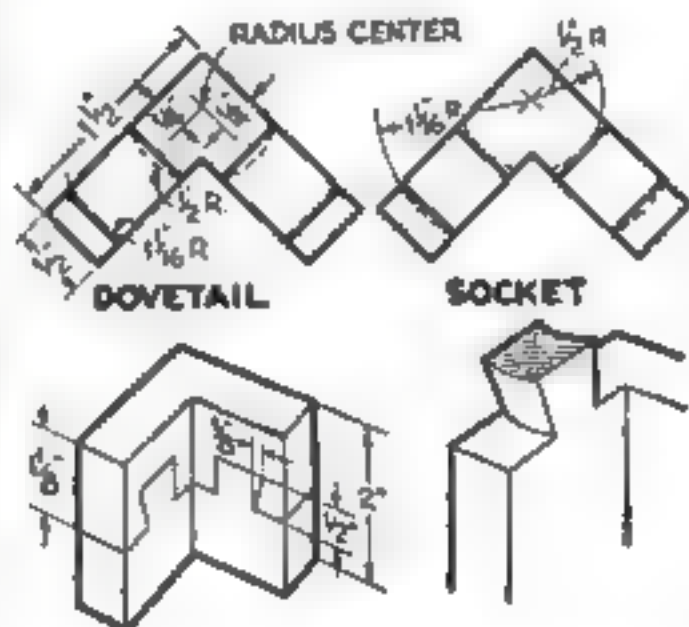
The parts of a wedged and stopped dovetail dado joint should fit tightly after the dovetailed member has been driven solidly into the groove cut for it

A dovetailed shelf end makes a secure joint with the cabinet side. One form, a wedged dovetail dado, is illustrated. The tenon is dovetailed on one side and tapered to fit into a corresponding tapered dado, which is stopped at the front to give the neat appearance of a nicely butted joint.



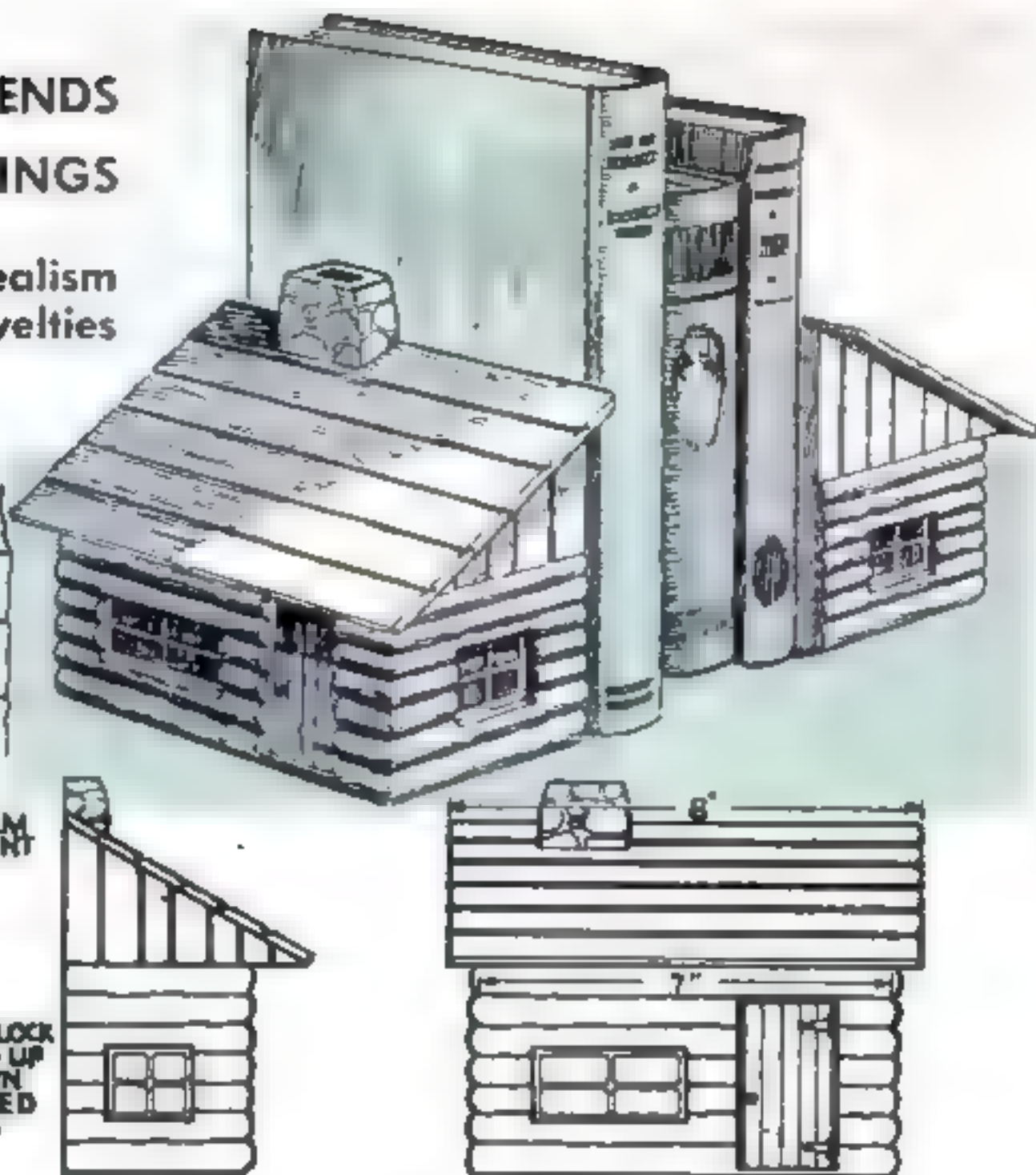
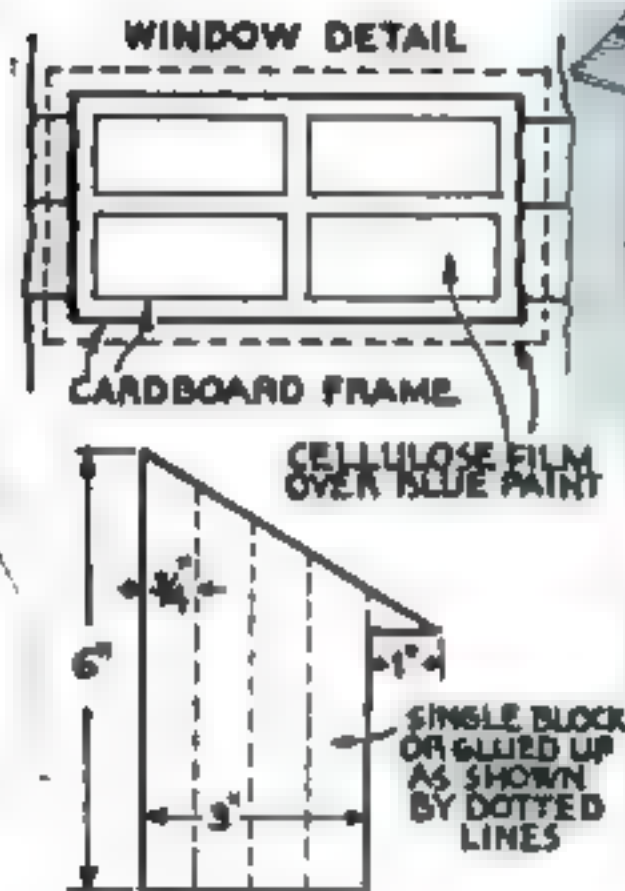
How Trick Joint Is Made

The dovetails below are segments of the same circle and can be revolved into the sockets. Lay out radiuses of $\frac{1}{2}"$ and $1 \frac{1}{16}"$ on mating ends of the right-angle pieces. Square guide lines for the dovetails—the outer ones tangent to the curve, and the inner as chords. For sockets, draw the inner lines tangent, and the outer as chords. Lay out side guide lines from the ends of the straight lines, and cut the joints square. Then round or hollow the sides until they will roll together.



LOG-CABIN BOOK ENDS FOR RUSTIC SETTINGS

Split Branches Lend Realism
to Walls of These Novelties



A BREATH of outdoors is brought to the den or study by these rustic book ends. Cut two blocks to the shape shown or glue them up from four thicknesses and a gable piece as indicated by the dotted lines. Make the roofs of thin strips of wood with the grooves cut at a slant; but make the cuts straight into the wood for the gabled ends.

Paint the window sections dark blue and cut cardboard frames for them, as illustrat-

ed. To create the illusion of glass, place cellulose film in each window area; then glue the frame over it. The edges of these frames will be covered when the logs—small, split branches—are nailed on. Groove the doors and glue on cardboard hinges. Insert big-headed pins cut short for knobs. A piece of sheet metal nailed to each cabin and extending under the books will prevent tipping. Glue felt on the underside.—GRAY WOLF.

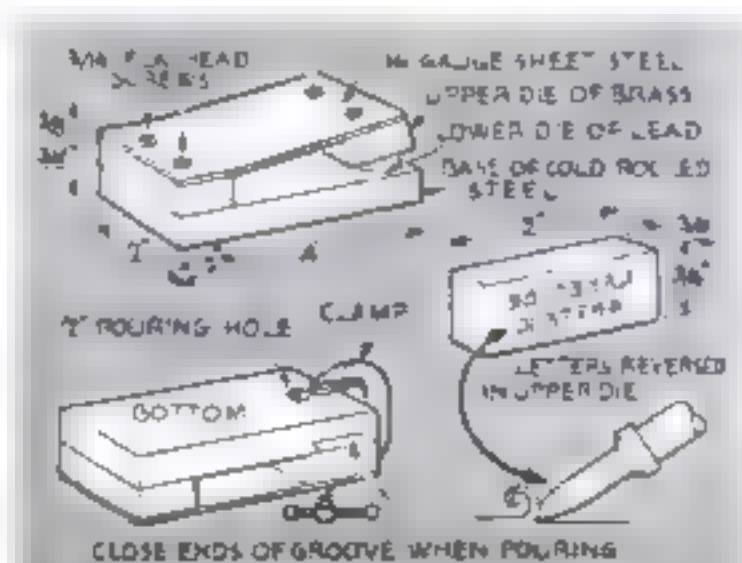
Homemade Die Embosses Names and Monograms on Stationery

MONOGRAMS, emblems, and other insignia can be embossed on fine stationery with the rigidly constructed die and press shown in the accompanying drawings. Place a brass block in a vise, and with a sharp scriber lightly outline the design in reverse. After making corrections for alignment, deepen the marks with a scriber until a cutting tool will follow in these depressions.

Cutting can be done with regular engraving tools, but an excellent one can be made from a phonograph needle

ground down to the shape of a tiny cape chisel. Care must be taken to avoid false grooves, and the final cut should leave letters $1/16$ " in depth and width.

To cast the mating die, clamp the cut die block in the homemade press shown and close the side openings of the dovetail slot with wood. Warm the assembly and pour molten lead or type metal into the $1/2$ " hole until both die and hole are filled. When the mating die has been trimmed, the press is ready for use.—G. A. BURROWS.



Dear Workshop Editor:

For cutting curves on heavy stock, a bandsaw's the thing.

But power tools are pretty scarce just now. Could you publish plans for building a husky bandsaw that will do ordinary work satisfactorily?

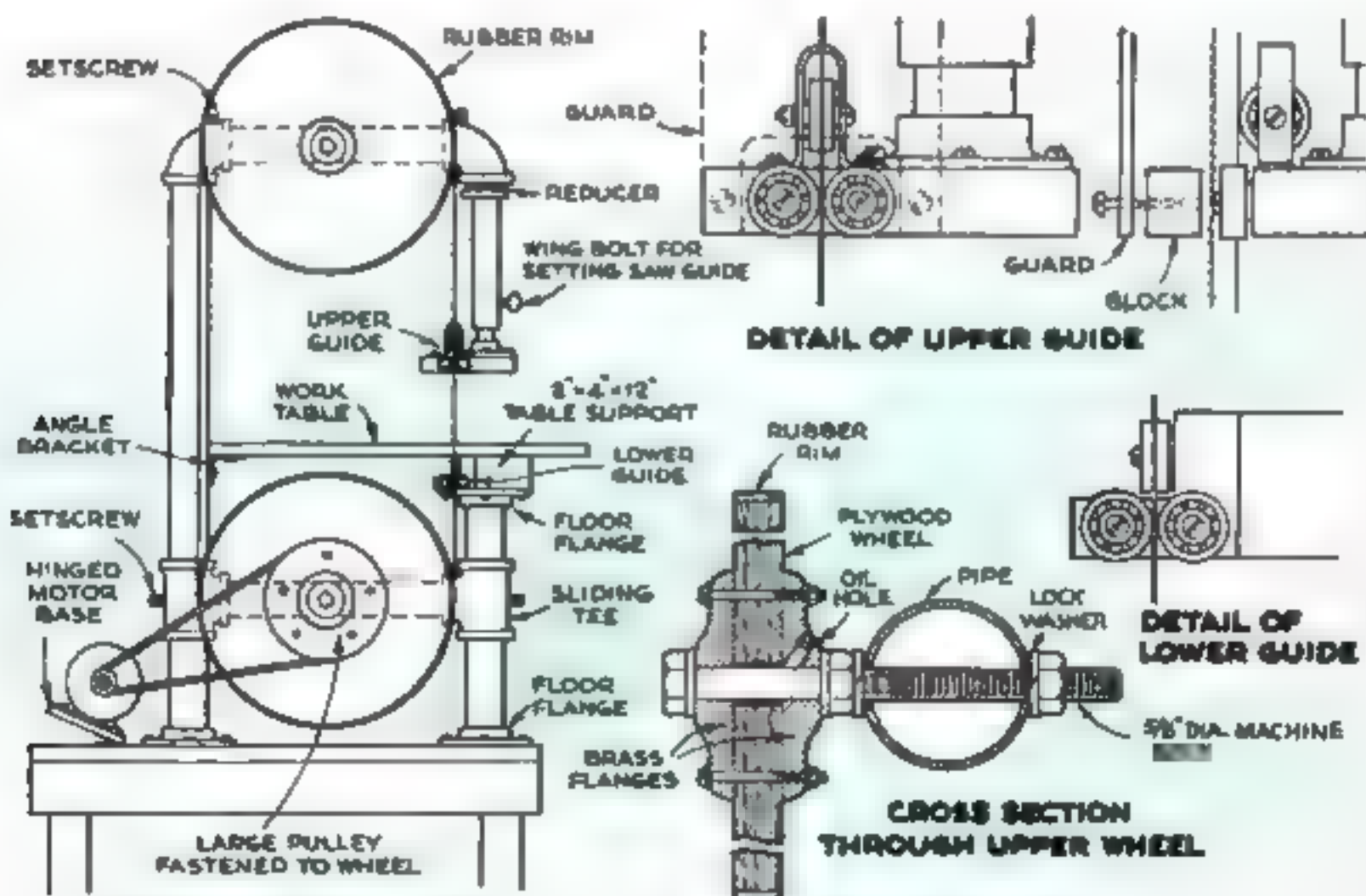
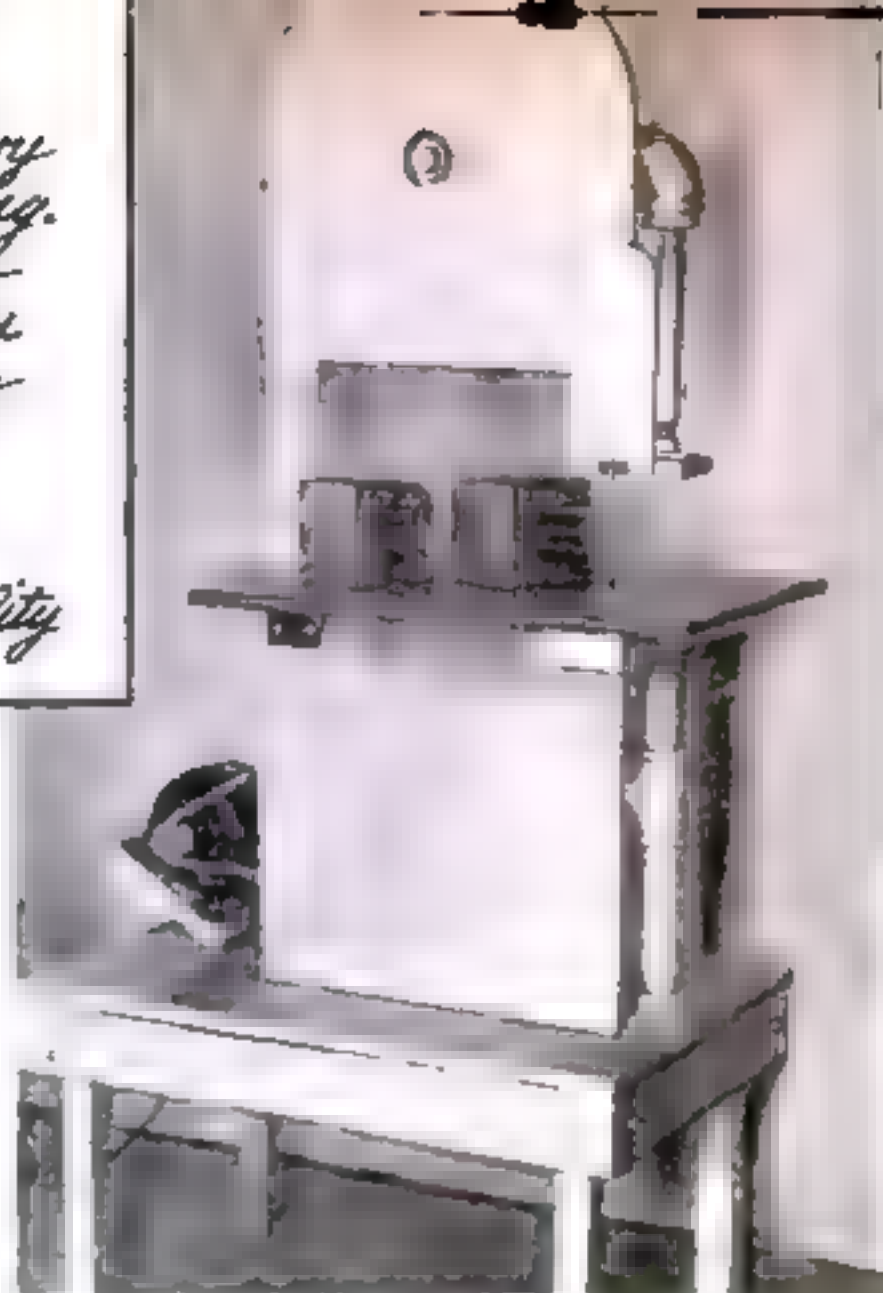
J. D.H., Salt Lake City

YOU are right, J. D. H. New band saws are hard to obtain, but an efficient saw can be constructed economically of available materials by following the plans below. Using pipe for the framework, and wood for wheels and pulley, brings the cost so low that the electric motor represents the bulk of the expense, and a motor might even be transferred from some other tool temporarily when a bandsawing job comes along.

The size of the saw can be varied, but the wheels should not be less than 14" in diameter nor more than 18". Pipe for the framework should be at least 1½" for a small saw, and 2½" for the largest. Fittings for the frame include one long and one short pipe for vertical members, and two pipes of the same length for

cross members—all threaded at both ends. Also needed are two pipe tees, two 90-deg. elbows, and three floor flanges, two for the base and one for the worktable.

Threads are removed from the crosses of both tees so that they will slide up and



down on the frame for adjusting the blade tension. Both are tapped for setscrews that lock them in position.

Drill holes in the center of both cross members to receive the bearing bolts, and drill and tap each elbow for a setscrew to bear on the upper cross member, which can be adjusted with a pipe wrench to tilt the top wheel and so make the blade track. The setscrew in the right-hand elbow locks the arm bearing the blade guide after this has been adjusted so that the teeth ride outside the guide rollers and the blade just touches the thrust roller.

Wheels are built up from $\frac{3}{8}$ " plywood disks and should be trued on the bearings on which they are to run. Ball bearings can be improvised

from roller-skate wheels, or other bearings can be made from brass pipe flanges drilled to take the bearing bolts. Rubber strips such as can be sliced from an inner tube are cemented to the rims of both wheels.

Blade guides consist of three small ball bearings like those shown below, and the thrust bearings can be mounted either as shown or else so that the blade rides on the side of the outer race. The upper guide is supported by a small pipe that telescopes into a larger pipe secured to the elbow, permitting it to be adjusted to the work. A small guard on this guide moves with it.

The motor should be $\frac{1}{2}$ hp. Blade guards can be fashioned of plywood and should extend well past the blade all around.—ROBERT L. EBY.

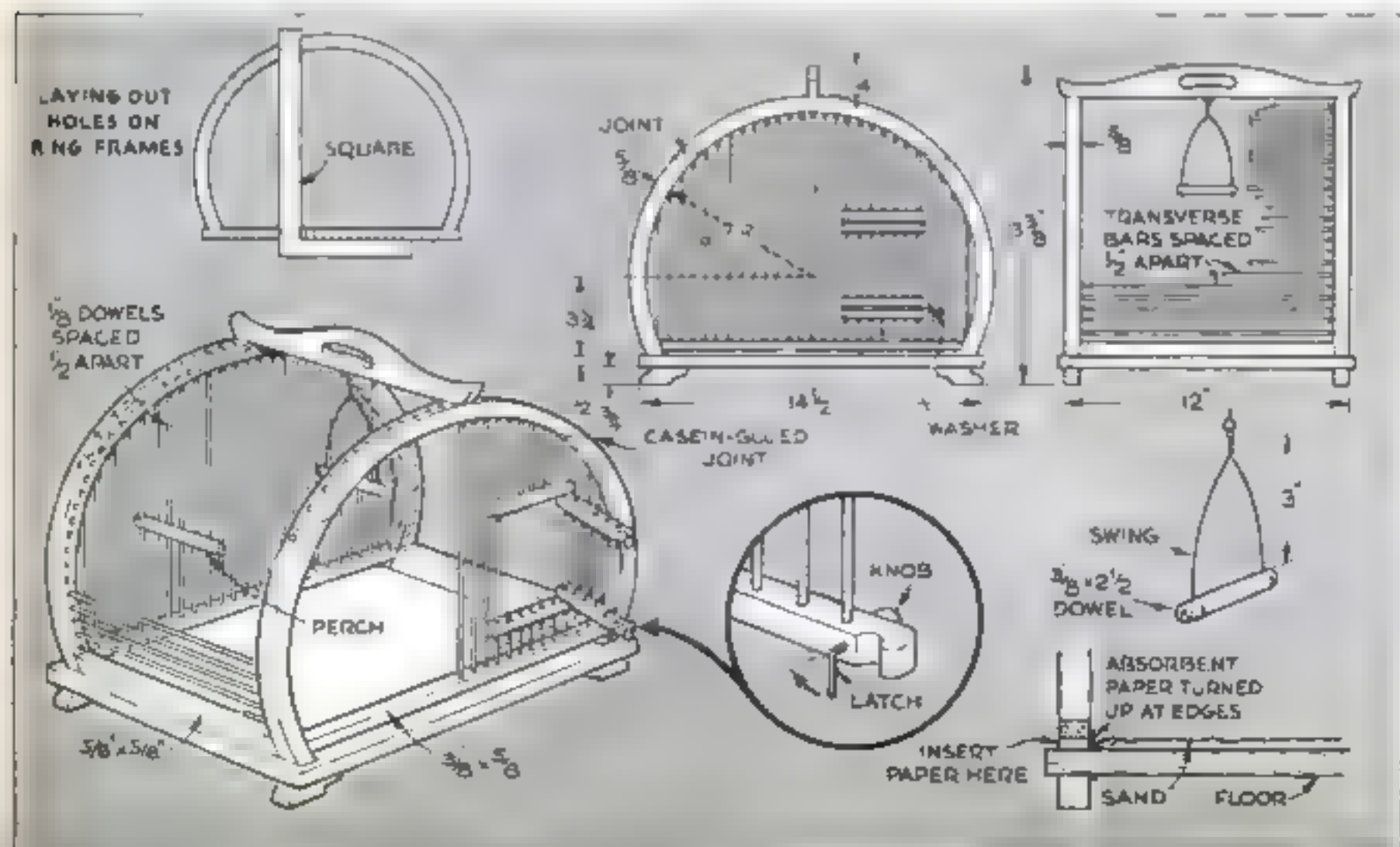


Dowels and Segmented Arches Are Combined in Sturdy Bird Cage

BUILT entirely of wood except for some screws, a washer, and a little wire, this bird cage is a good project for the craftsman who wants to try something different. From $\frac{1}{2}$ " hardwood make a pair of ring frames, each in three sections so as to have the grain running lengthwise for strength.

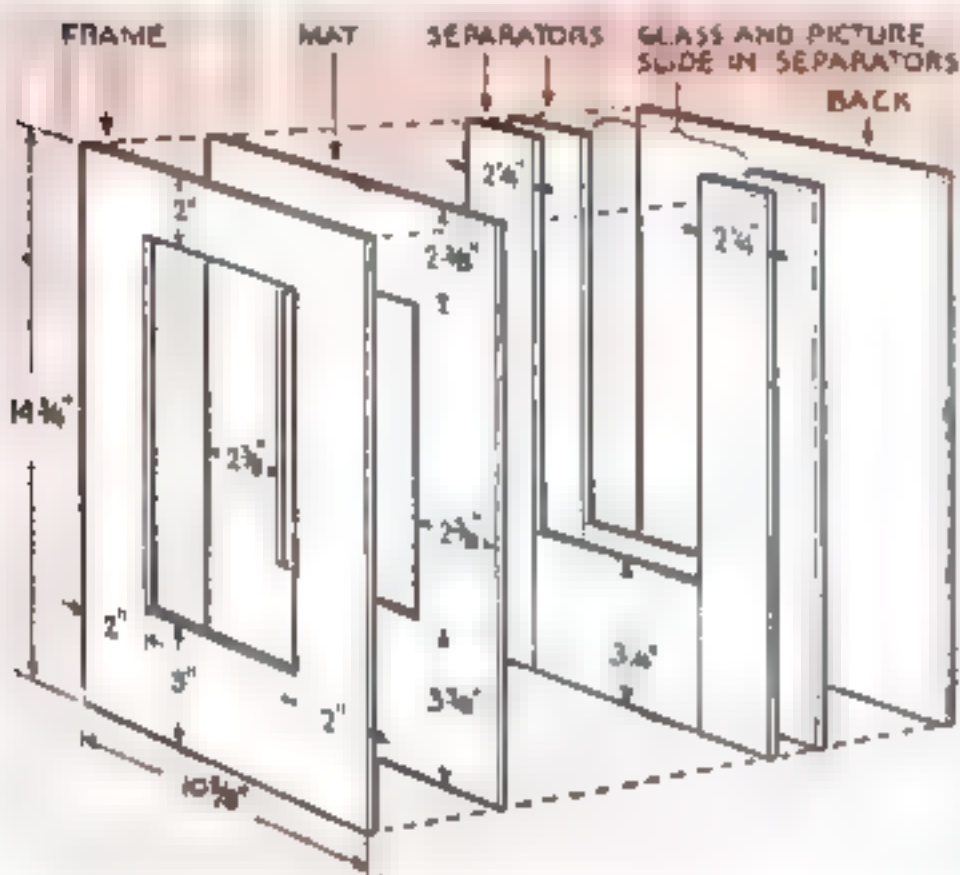
Cut the other parts; then draw parallel lines $\frac{1}{2}$ " apart on the lower rails, clamp one of these and one frame together, and square lines across to locate the holes to be drilled for the vertical bars. Use dividers to locate the holes for the horizontal bars. Drill all holes, including those in the rails which receive the vertical bars, for $\frac{1}{8}$ " dowels.

Attach the ring frames to the baseboard with screws driven from beneath. Insert the horizontal bars first, and then the vertical ones. Note that two of the latter pass through each joint of the frames, reinforcing them. Cut an opening for the door by removing $3\frac{1}{2}$ " sections from five of the bars, using these pieces in the door itself. One of the full-length cage bars serves as a hinge, and the bottom rail of the door rests on a washer. The latch is a piece of wire with a knob soldered to it. A swing and a perch are made of $\frac{3}{8}$ " dowel. If neatly built, this cage is more attractive unfinished than when painted.—H. S.

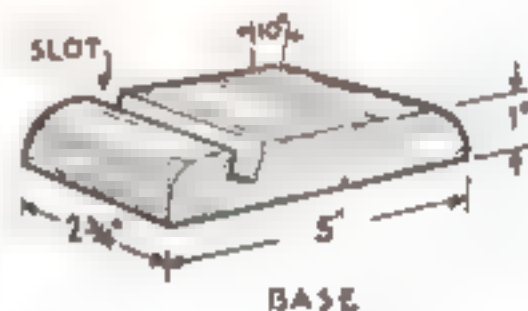


Two-Toned Frame of Cardboard Is Tailored to Suit Pictures

SUITABLE for displaying full-page color pictures such as those that appear in POPULAR SCIENCE MONTHLY, this laminated frame is glued up of five layers of cardboard or matboard, as shown in the exploded drawing below. Note how the two layers next to the back are left open at the top to provide a slot for the insertion of the picture and its protecting glass. The broad facing of the frame in the photo has an eggshell finish in French gray, while the inner border is cut from a beige mat of similar texture. Home craftsmen will find that by varying its size and color combinations, such a frame can easily be tailored to flatter their favorite pictures if patterns are cut and tried first.—C. W. B.



Supported by its wooden base, which tilts it slightly backward, the frame ornaments a desk. At its back is a tab for hanging



APRIL CHECK LIST

[SHIPSHAPE HOME]

1. Inspect foundation and walks for damage from winter freezing.
2. Check stucco walls for cracks and loose spots.
3. Sweep around outside foundation walls and inspect for termites.
4. Scrape and clean outside ironwork that needs painting.
5. Inspect porch piers and repair or build new
6. Clean and paint outdoor and porch furniture.
7. Repair and prepare porch floors and steps for painting.
8. Brush and clean efflorescence on brickwork with acid wash.
9. Repair and paint flower boxes to be ready for early use.
10. Check for dampness throughout the house during a heavy rain.

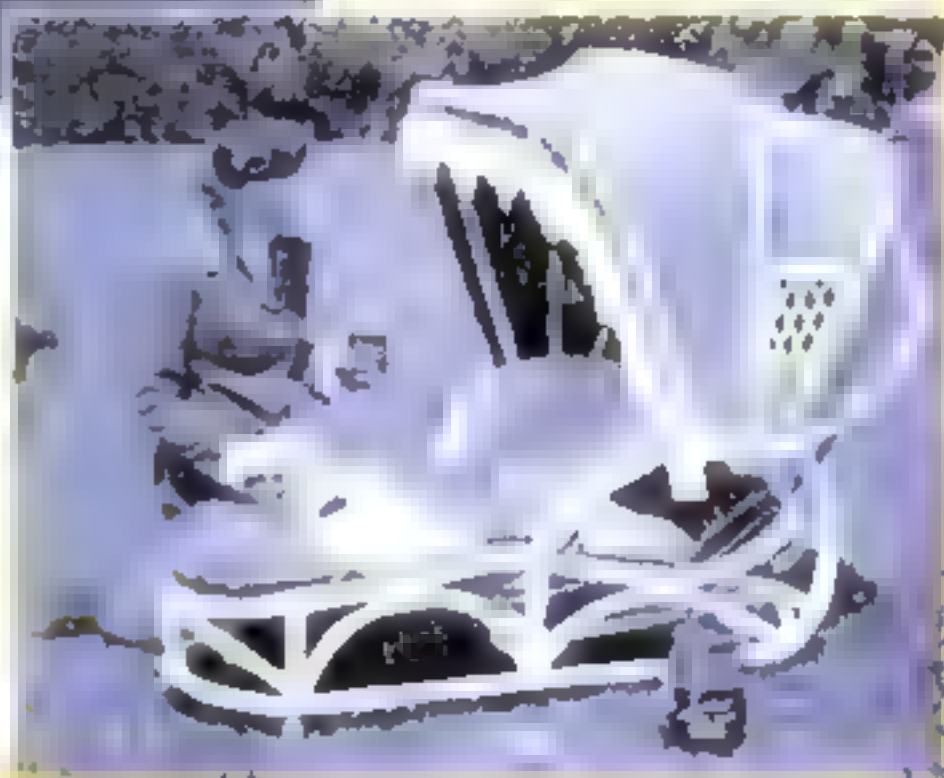
POPULAR SCIENCE MONTHLY SHOP DATA

AIDS TO *Modern Living*



An old fiber rug will wash easily after being treated with this chemical coating

New life and color can be given to dingy, faded lawn-seat cushions and awnings



CANVAS CAN BE PAINTED with a new chemical coating that is water-repellent and comes in 10 fast colors and black and white. The paint will not crack or stiffen fabrics, can be sprayed or brushed on, and can be employed to refresh fiber rugs, since it is very penetrating and imparts strength and pliancy to any fiber that absorbs it. An auxiliary product, a clear liquid overcoating can be brushed over the canvas paint to give it double wearing qualities. A mildew-killing agent in the coating makes it useful on objects exposed to rain, like canvas golf bags and beach chairs.



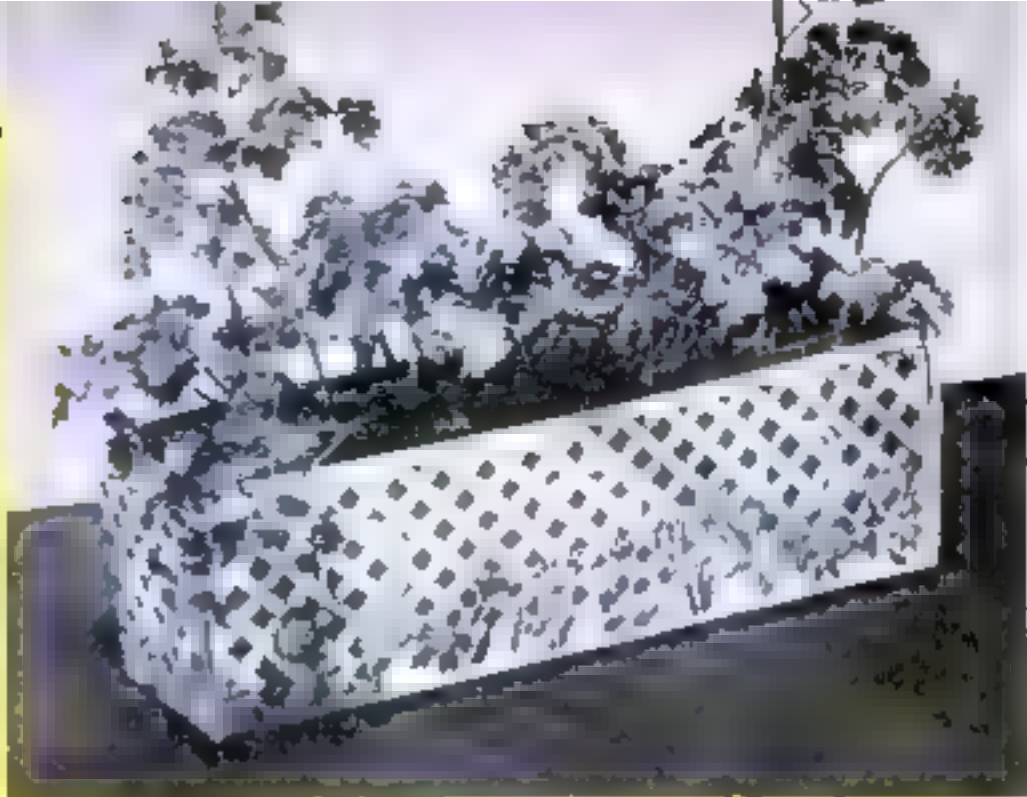
CORRUGATED LEATHER SHOE SOLES that provide a nonslip surface, but which do not forfeit any of the wearing qualities of an ordinary sole, may be found on the market after the war. First designed for the uncertain feet of children, the corrugated sole, specially processed for flexibility will be adaptable to many kinds of work and street footwear.

A TWO-EDGED RAZOR BLADE supported by the side strips of a small plastic holder, like the one below, will prove a handy pocket knife that is safe to carry and can always be kept sharp by an instant change of blades. Inclosed between two panels that slide into a C-shaped frame, the exposed edge of the razor blade is protected when its holder is turned inward in the frame. To change to a cutting position the blade holder is pulled out, reversed, and reinserted in the frame, which holds it firmly.



PARSLEY WILL GROW on a window sill, and keep a kitchen well supplied, if a box like the one at the right is sprinkled with water and given a spot in the sun. Filled with rich earth and sown with seeds preplanted at just the right depth, these flats also contain chemicals that promote a crop. The box itself will withstand frequent waterings

RAYON-AND-WOOL FABRICS should be cleaned with cold water when spotted with fruit stains; with talcum if freshly soiled with light grease; with carbon tetrachloride for old, heavy grease spots; with a bleach if disfigured by scorching, and by hand-rubbing the fabrics for water rings



DIRTY HANDS BECOME CLEAN when rubbed with a small amount of a liquid cleanser like that in the bottle above. Sinking into the pores, the solution dissolves the grease and brings it to the surface in an emulsified form, which can be easily rinsed away

NUMEROUS REPAIR JOBS around the house can be accomplished with a new plastic substance that will not crack at sub-zero temperatures nor flow under heat. Shown below, this mending compound dries slowly and does not become extremely hard like some crack fillers containing very volatile solvents. It will stick to most dry surfaces if made tacky by kneading



BUGS WON'T FEAST on your climbing roses next June if you wet the bushes from top to bottom with insecticide from this sprayer, which throws a fine stream from 15' to 25'. Holding a quart, the sprayer, pumped by hand, can also be fitted with a nozzle giving a fine spray for closer work

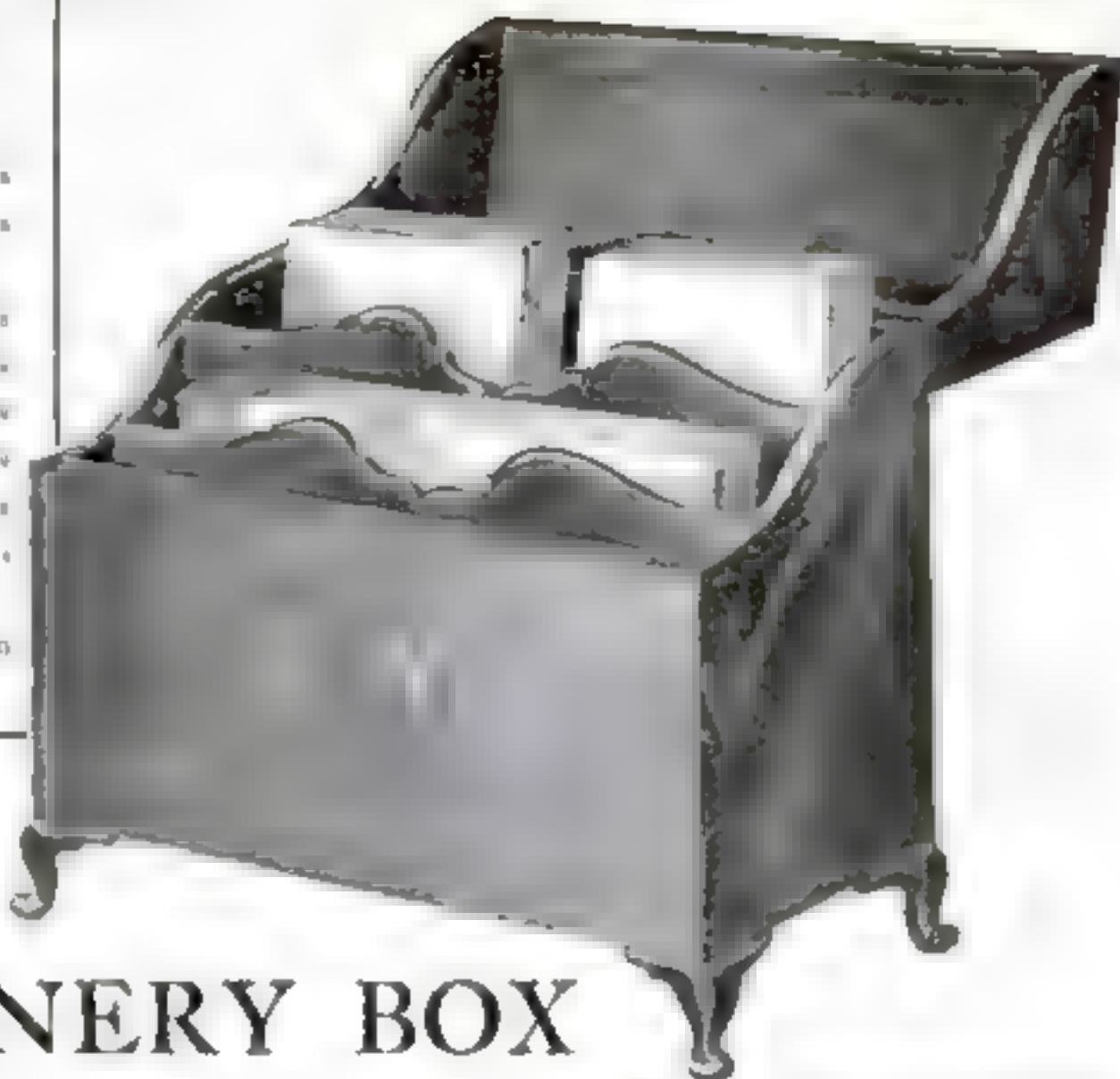
GENERAL CLEANING of the kind that requires a strong grease solvent like ammonia can now be done with a newly marketed substitute. Shown at the right, the detergent has an odor of pine instead of the acid smell of real ammonia. It won't explode, and never loses its strength



LIST OF MATERIALS

No.	Pc.	Description	T	W.	L.
1	Front		$\frac{1}{4}$	6	$7\frac{1}{2}$
1	Back		$\frac{1}{4}$	$6\frac{1}{2}$	$7\frac{1}{2}$
2	Sides		$\frac{1}{4}$	$3\frac{3}{4}$	6
1	Lid front		$\frac{1}{4}$	$2\frac{1}{4}$	$7\frac{1}{2}$
1	Lid top		$\frac{1}{4}$	2	$7\frac{1}{2}$
1	Bottom		$\frac{1}{4}$	$3\frac{3}{4}$	$7\frac{1}{2}$
1	Partition		$\frac{1}{4}$	$3\frac{3}{4}$	$7\frac{1}{2}$
1	Partition		$\frac{1}{4}$	$6\frac{1}{4}$	$7\frac{1}{2}$
4	Foot blocks		$1\frac{1}{4}$	$1\frac{1}{4}$	$3\frac{1}{4}$
1	Pair $\frac{1}{4}$ "	brass narrow butts			

Note: All dimensions are given in inches.



Queen Anne Style

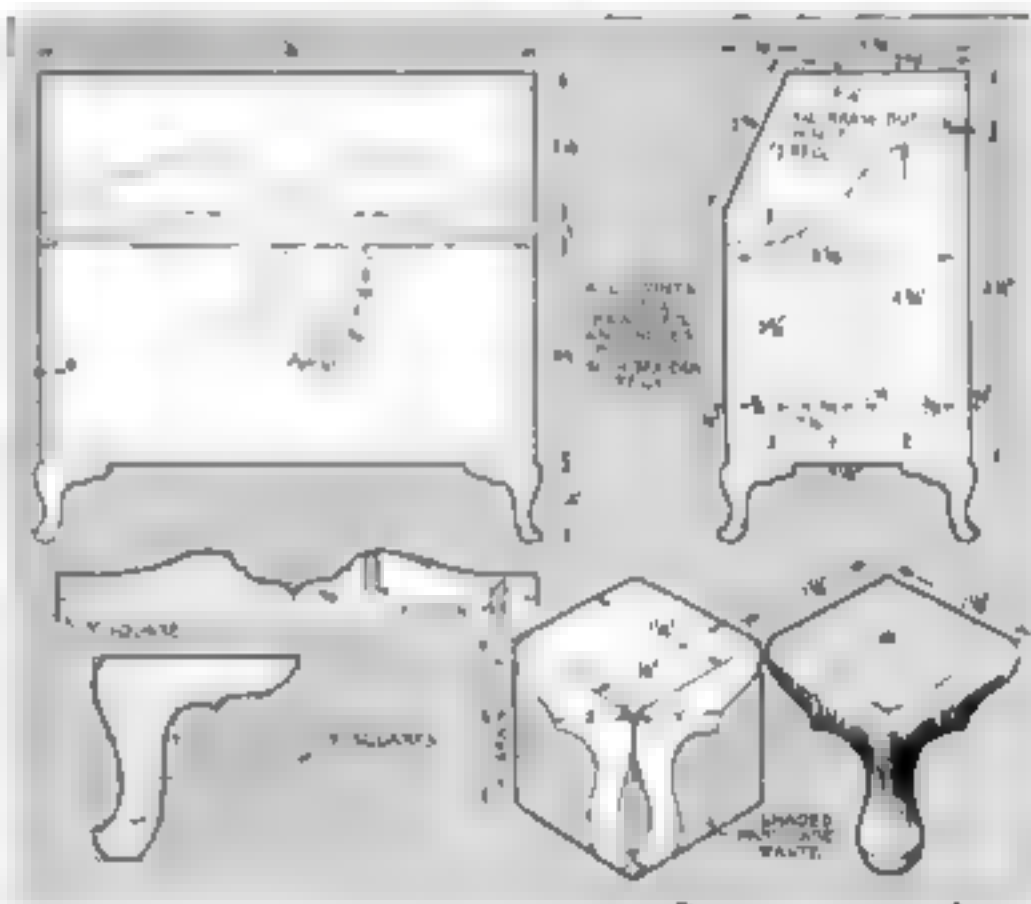
STATIONERY BOX

MADE of nicely grained $\frac{1}{4}$ " mahogany or other wood, and inlaid with metal initials, this box for stationery can be assembled with precision if it is constructed as a unit and a bandsaw is used to cut apart the lid and the lower portion. In following this procedure, be sure to make grooves in the side panels for the partitions before assembling the box unit.

After cutting all stock to size, plane and sandpaper it before outlining and chiseling the channels for the inlaid initials. If the letters are to be of pewter or copper, scribe their shape with a pointed instrument and cut them out with a jeweler's saw. Score the initials on the back, apply glue, and squeeze them into place with a clamp.

When cutting the partition grooves in the side panels, it is good workmanship to stop them at the floor, but no harm will be done by carrying them to the edge. Lay out patterns for the partition tops on $\frac{1}{2}$ " squares, as in the drawing; then shape them with a jig or coping saw, but glue them in place before beveling their ends flush with the curve of the side panels.

For the cabriole legs, first outline a full-size pattern of a leg as shown in the drawing and trace the pattern on four blocks of wood $1\frac{1}{4}$ " square. Next, saw the lines marked X,



using a jigsaw or coping saw, nail the waste pieces back on the blocks, and then saw along the lines marked Y. Round the feet and legs with a knife, sandpaper them well, and glue them to the box, securing them with small screws.

Hinge the lid with two narrow brass butts. Give the box a mahogany stain, and rub in filler colored with the stain. Then apply several coats of varnish or shellac—enough to build up a good surface for rubbing with pumice and oil.—F. H. G.



GLASS SINKS, heat-tempered for strength to resist heavy shocks, have been tested with good results since the first units were installed in 200 apartments of a housing development in Bridgeport, Conn. Modern in design like the one at the right, the new sinks come in black and pastel colors. They do not absorb stains, and are said not to be subject to the chipping that sometimes disfigures ordinary enamel-coated sinks.

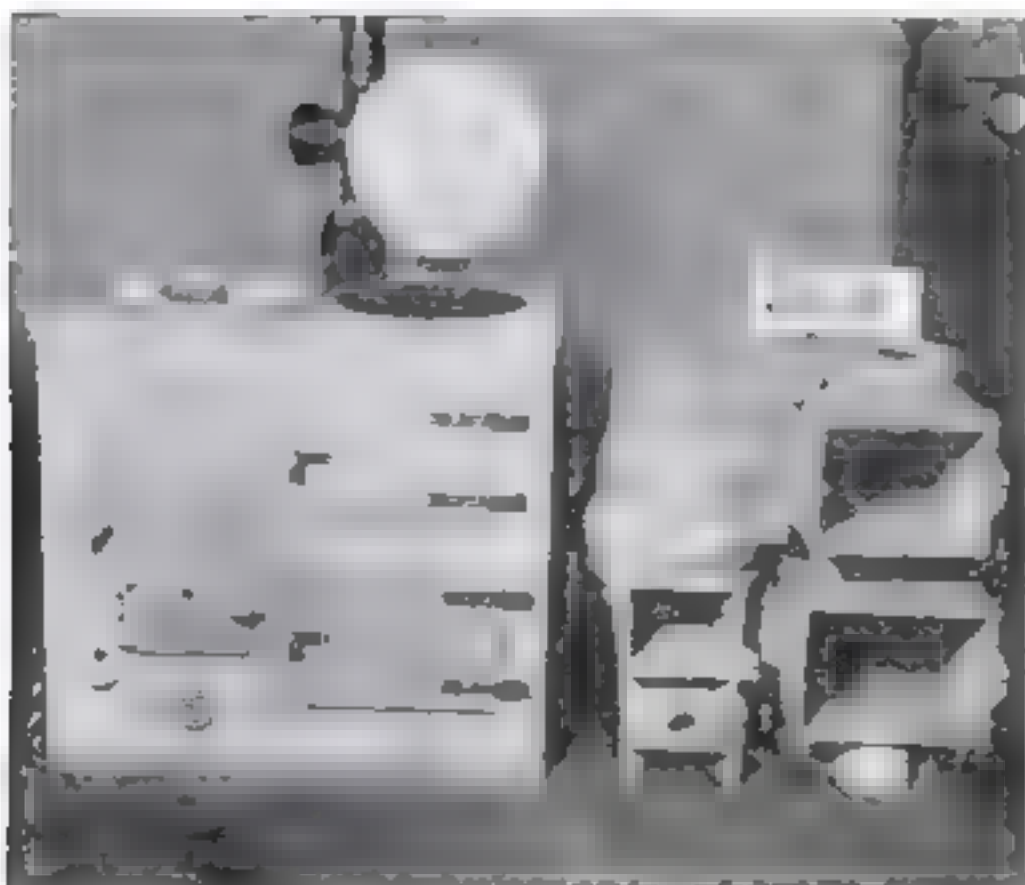


ABSORBING WATER up to 40 percent of its own weight, a new dehydrating powder containing calcium chloride turns into a damp,

claylike substance when saturated, and therefore can be used without fear of spilling in trunks and closets where a rust or mildew preventive is required. It can be reactivated indefinitely by heating in an oven to drive out the moisture. Placed in a refrigerator, it retards the frosting of the coils.



ELECTRIC ATTACHMENT PLUGS containing no screws can be connected securely to a lamp or appliance cord without the aid of any tool other than a small nail or stiff wire with which to dislodge a pair of two-ply springprongs from their shallow grooves. When the prongs have been removed, the cord is inserted and its two bare wires spread across the top of the plug. Replaced, the prongs hold the wires in a firm contact.



CERAMIC COAL RANGES, said to be the first of their kind, contain only 80 lb. of metal and are being manufactured in a style that utilizes an unusually small fire to heat a hot and a slow oven and a hot and a simmering plate. This newcomer to the kitchen employs an automatic draft control to keep the range at a desired temperature all the time it is in use, and the heat is distributed both by the gases of combustion and by radiation from a cylindrical fuel magazine inverted over the coals. Its revolving grate is refueled from an automatic filler, and ash removal has been made dustless. The hot plate can be heated to 725 deg. for fast cooking, while the simmering plate will heat to 460 deg.

D I S T I N C T I V E

Colonial Wall Rack

MAKES A DECORATIVE PIECE FOR YOUR LIVING ROOM

By FRANK HEGEMEYER

INTENDED primarily as a decorative piece, this wall rack in the Colonial manner reflects beauty and good taste. Its sturdy construction gives it utility as well, for it may also be used as a hanging bookshelf for small volumes. The warmth and attractiveness of its traditional Early American design are probably best displayed, however, if it is used to hold plates, small figures, and bric-a-brac.

The rack is made principally of $\frac{1}{2}$ " maple, although birch can be substituted. The list of materials gives the dimensions of the stock from which the pieces are shaped. Because of the number of doweled and glued joints involved, it's wise to use a slow-setting glue when assembling the rack, and to lay

out the parts in proper position before gluing, with clamps, glue, and dowels in easy reach. The shelves and the slatted back may be built as separate units and later joined with wood screws and glue. Bore holes for the screws in the shelves, and use a little oil or soap on the screws to prevent binding.

Though it may seem excessively painstaking, you will probably find it helpful to number each dowel hole and dowel end as the pieces are formed, renumbering them when they are turned or shaped. The chance of error in assembly will thus be minimized.

The dowel holes in the three finished posts and in the slats are bored before the work is shaped. The stock for the posts should be perfectly square, and the dowel-hole locations laid out, as in one photo, by means of a



The shelves and slats may conveniently be rounded on a drill press which is equipped with a molding cutter. Rounding should be done on the underside

The dowel holes are located accurately by means of a marking gauge set to meet the lathe center hole



Concave surfaces on the ends of the slats can be produced by holding them against a $1\frac{1}{16}$ " sanding drum. A support block is mounted on the rest

Dowel holes in the posts and slats will coincide if brads or dowel centers are used to locate them



marking gauge adjusted to meet the lathe center hole at one end of the stock.

Before cutting the shelves, note that the centers of the $\frac{5}{8}$ " radius cuts at the rear corners are located $\frac{5}{8}$ " in from the sides. The tenon hole centers for the vertical tapered posts are placed $\frac{5}{8}$ " in from both the front and sides. The four convex-shaped back slats are centered between the adjoining shelves. Note that the lower two shelves are grooved to provide a safe support for decorative dishes.

If you wish to form these grooves with a circular saw, they can be cut blind—not extending to the shelf ends—in the following manner. Nail two small heel and toe blocks 34" apart on a wood strip 2" wide and 40" long. Clamp this jig to the inside of the ripping fence, locating the blocks equidistant from the blade. At the start of the cut, the shelf is placed with one end against the heel block, the one nearest the operator. It is then lowered onto the blade and advanced until stopped by the toe block.

A warm-toned finish can be achieved by the use of a penetrating maple stain, which will produce full, uniform tones, without streaks or laps. No filler will be required with maple or birch. If you lacquer the piece, apply a sealer coat and then finish with clear lacquer. Varnish may also be used if it is rubbed to a semi-gloss. Care taken in finishing this rack will be well rewarded.



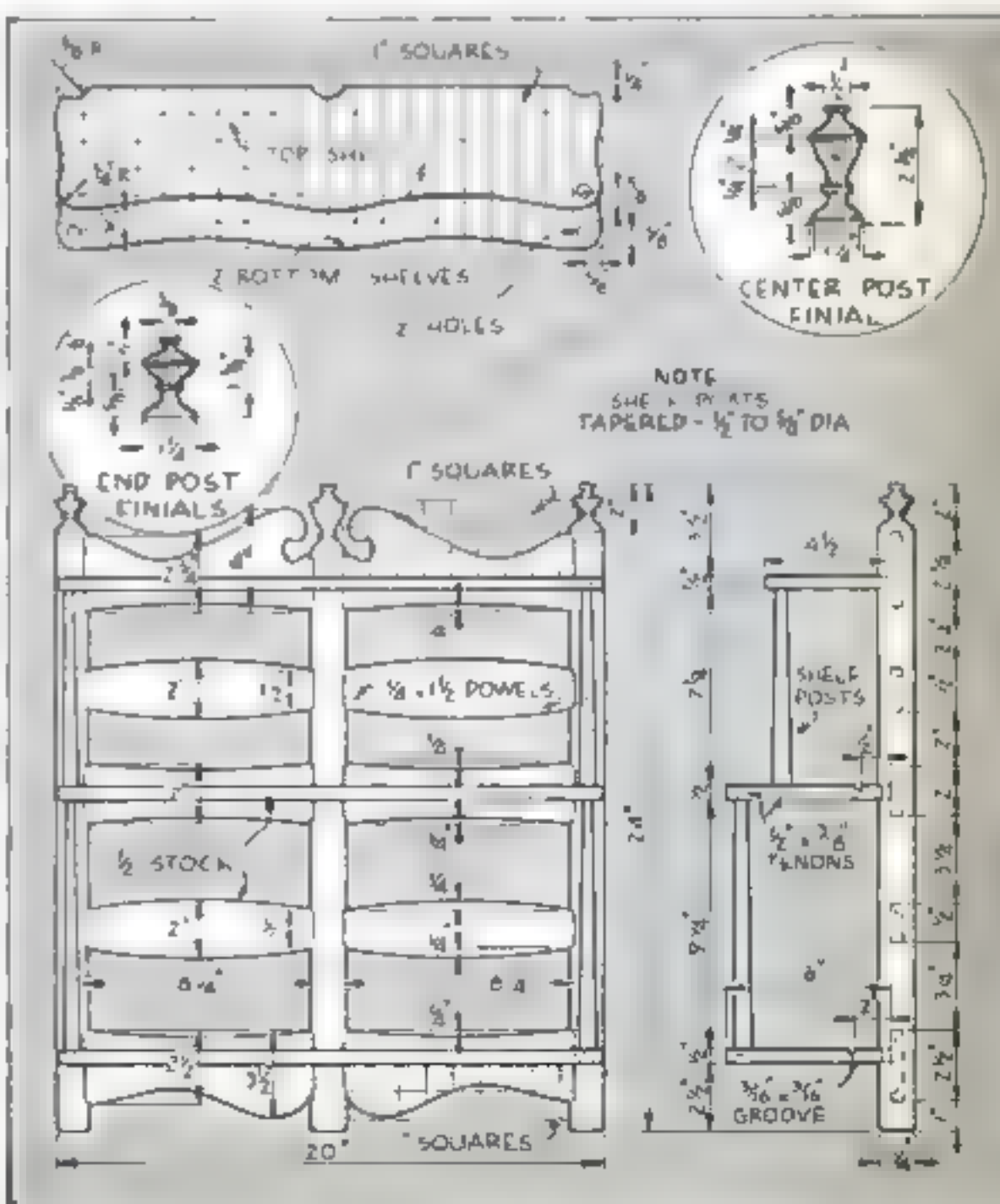
Although this wall rack can be used as a bookshelf, the grace and charm of its lines are best displayed if it is used only as a decorative piece. The finials on the posts represent a good exercise in careful craftsmanship on a woodworking lathe.

LIST OF MATERIALS

No.	Description	T.	W.	L.
3	Turning squares for posts	1 1/2	1 1/2	25
6	Center slats	1/2	2	8 1/2
2	Upper slats	1/2	4	8 1/2
2	Lower slats	1/2	3 1/2	8 1/2
1	Top shelf	1/2	4 1/2	20
2	Lower shelves	1/2	6	20
2	Upper shelf posts	1/2 dia.		9
2	Lower shelf posts	1/2 dia.		11
40	Dowels	1/2 dia.		1 1/2

NOTE. All dimensions are in inches.

Also needed: 12 flathead wood screws, 1 1/4" long. No. 6 or 7; cold-setting glue; penetrating-type maple stain.





RUBBER HOSE

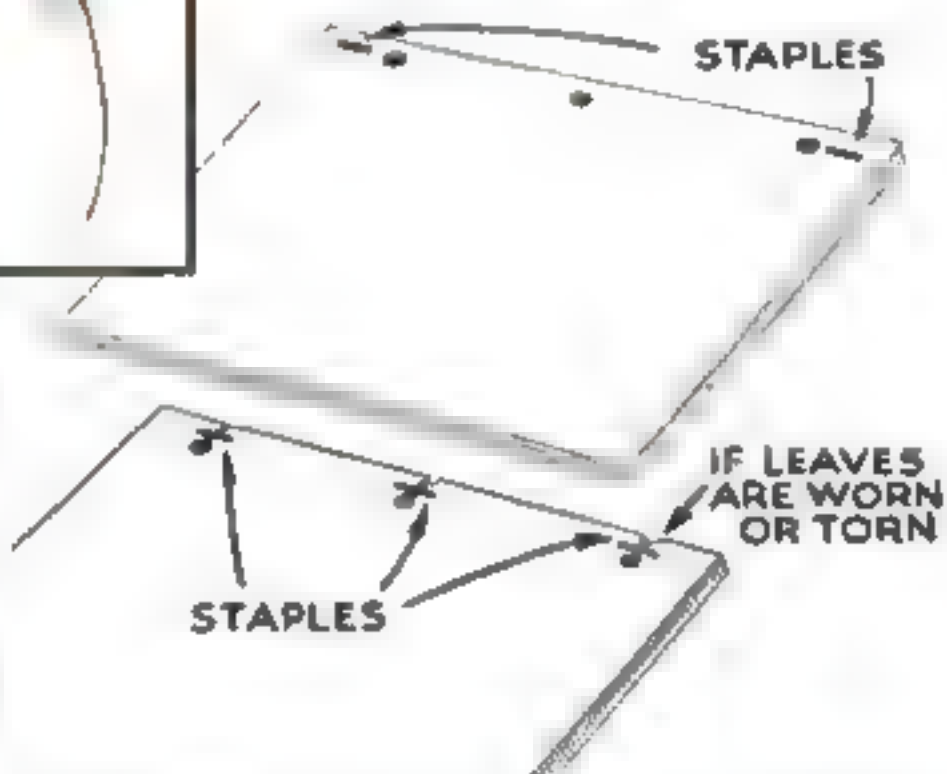


Spading is made easier on the feet by impaling a split length of hose on the spade handle and then pushing it down over the shoulders of the blade



EDGE CUT AND TURNED

By cutting and bending the serrated metal edge of the carton, you can cut wax paper in half as it is pulled from the roll, as above. For full width, lift the paper over the cutter



Ring holes in loose-leaf books can be kept from tearing by fastening used sheets together with a hand stapler. Apply three staples on worn paper

Two stout leather straps riveted together and nailed to a wall in the manner shown below will make a novel holder for one flowerpot

Hair and lint can be removed from serge clothing with adhesive tape wrapped, adhesive side out, on a magazine. Roll it over the cloth

A slit in oilcloth will hardly be noticeable if adhesive tape is applied to the underside of the cloth to hold it together



BRADS OR RIVETS



ROLLED MAGAZINE

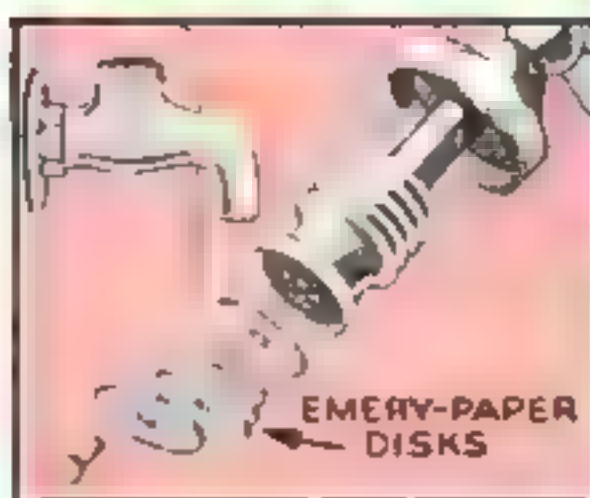


ADHESIVE TAPE APPLIED TO UNDERSIDE

SLIT



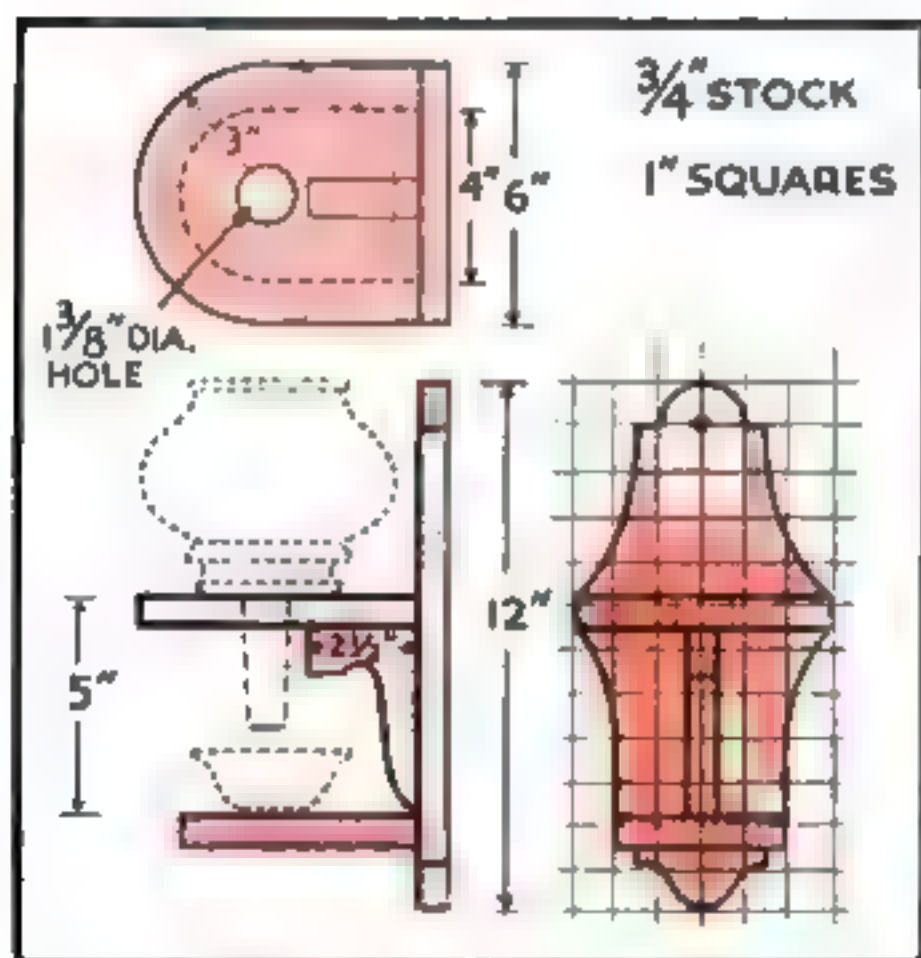
When ski poles aren't in actual use, it is a good idea to keep the points covered with erasers



To true a pitted faucet valve seat, put abrasive disks on the stem and twist it in the faucet



Most worn-out typewriter feet can be replaced satisfactorily with others cut from old rubber heels



Made of pine, the hanging wall bracket above is both decorative and handy for racking away the top of a glass coffee maker when it's not in use

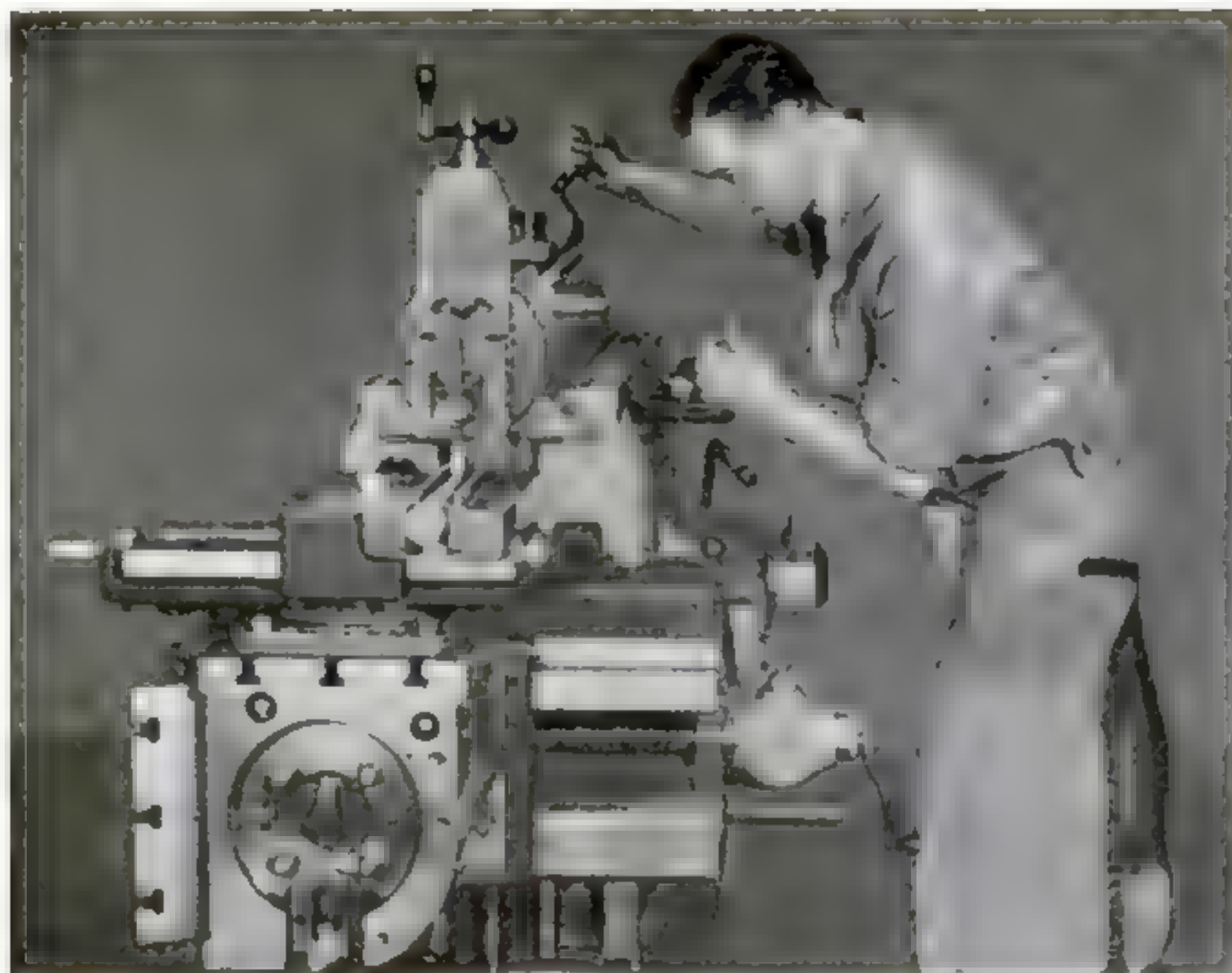
Hangers screwed to a template laid out as in the drawing below will serve as a pattern for fitting outside screens and storm sash. Keep the ends flush for a perfect fit. Use the lower section as a guide in screwing hooks to the window frame, and the upper one for fitting eyes on the sashes



ORNAMENTAL CAP



Stripped threads on the finial of a lamp shade can be made to hold tightly once more if they are covered very thinly with a layer of solder



Cutting a Keyway on the Shaper

Round Work Is Easily Centered for Machining a Stopped Slot

DOUBLING for a slotter or keyseater, the versatile modern power shaper can be used for cutting keyways accurately in round stock if a few precautions are observed to be sure that the work is properly held. It is particularly important that the shaft be so clamped that the center line of the keyway will become the vertical diameter, for otherwise the sides of the slot will be at an angle that will not fit the key.

In the photographs on the succeeding pages, the work is shown clamped in the shaper vise with shims of a soft metal such as copper between it and the jaws to keep it from turning, and it is set on a parallel bar to raise the top surface to a convenient height for shaping. V-blocks might have been placed between the jaws instead of the shims, providing a clamping action that would hold the work steady. The V-blocks would also hold the work horizontal without the necessity of resting it on a parallel base.

Other methods of clamping cylindrical

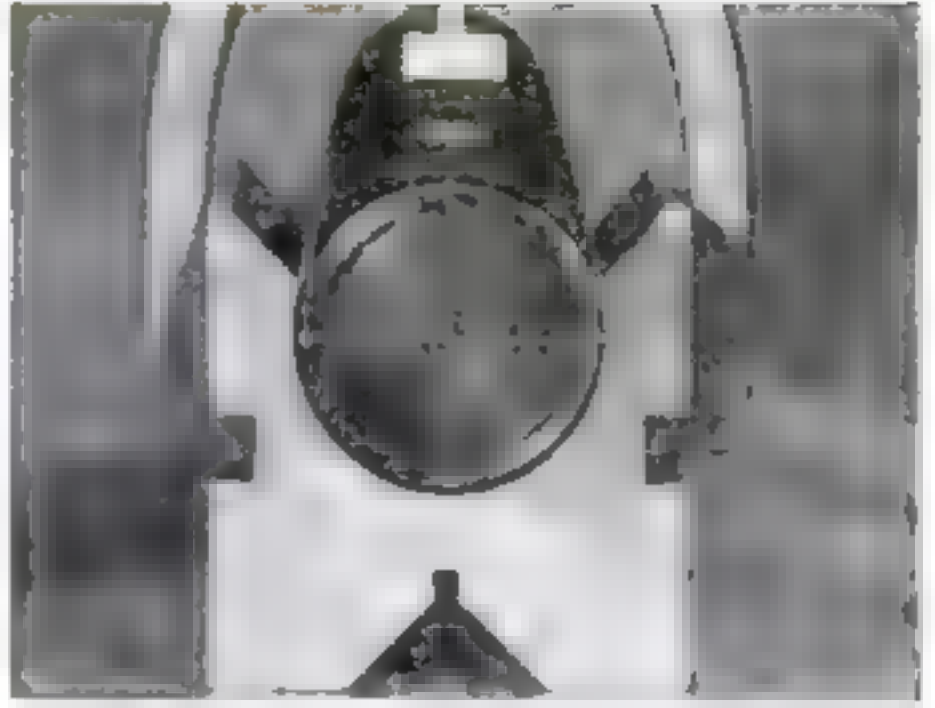
work are practicable when using the slots in the shaper table instead of the vise. Rigid anchorage may be obtained, for example, by employing a fixed wedge on one side of the shaft and a wedge block on the other, the tapers being toward the table so as to press down. The wedge is clamped with a stop pin having the screw slightly above the center of the work. L-clamps held to the table by bolts and stops may also be used.

Since the keyway is a stopped slot in the shaft specified for the job illustrated, a hole is drilled at the end to provide clearance for the cutting tool. This hole does not affect the use of the key in the finished keyway even though the key extends into half of it.

The cutting of such a keyway on the shaper is the subject of one of the motion pictures produced by the U. S. Office of Education and distributed by Castle Films as an aid in training war workers for machine-tool operation. The photos showing steps in the job were selected from this film.



1 This is the job To cut a $\frac{1}{4}$ " by 3" keyway in a cylindrical steel shaft. Depth is measured from the bottom of the shaft. A hole drilled at the end of the stroke provides for tool clearance

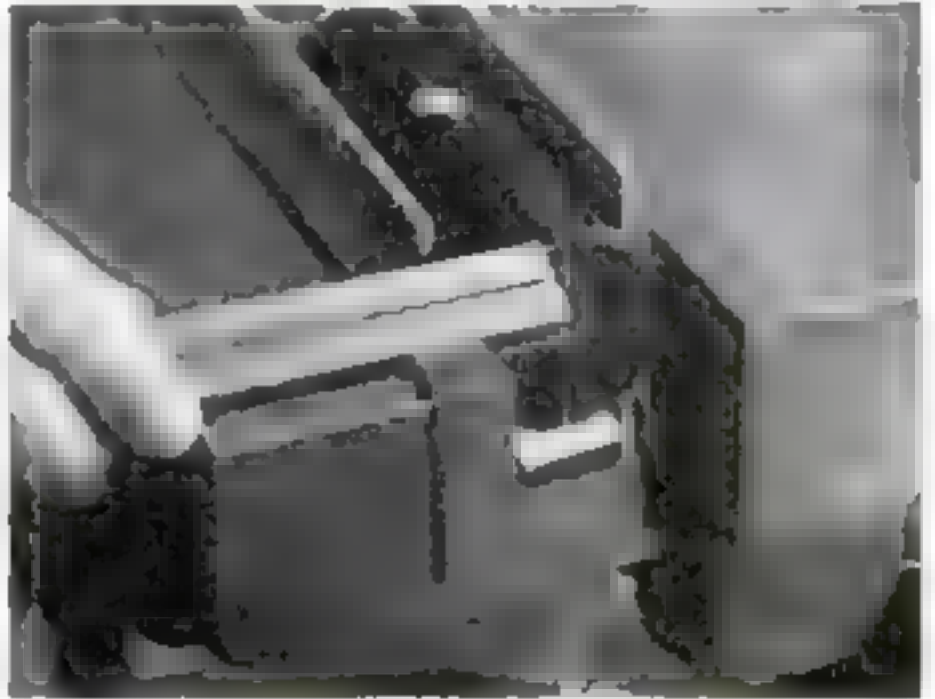


2 Clamp the shaft securely in a V-block so the perpendicular diameter will be the center line of the keyway; then lay out the width on the end and use a surface gauge to transfer it to the top



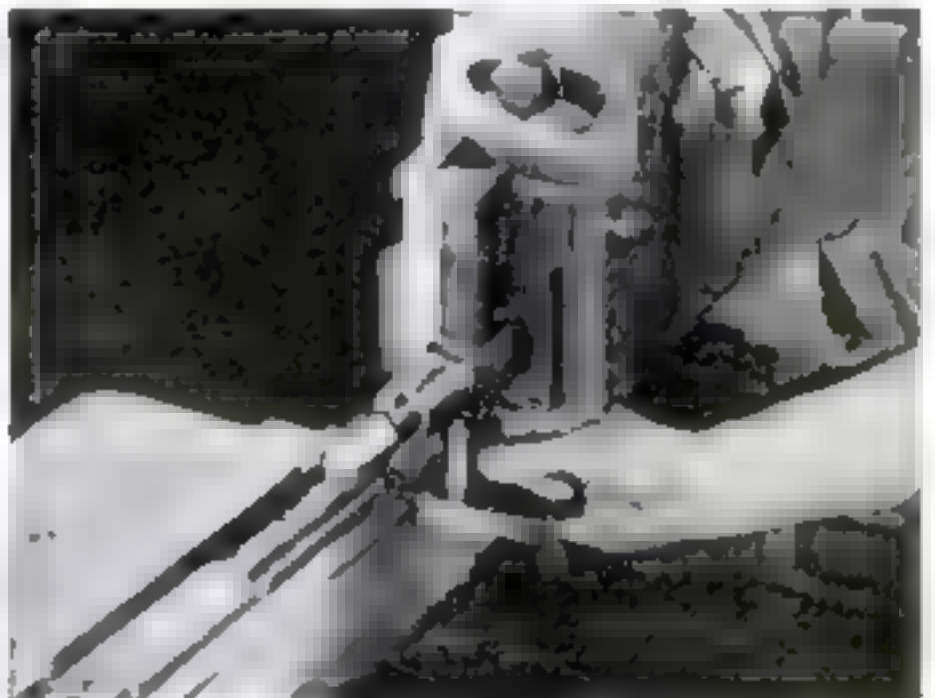
3 To keep the tool in line with the layout, set the shaper vise parallel to the stroke. Check with a dial indicator clamped to the tool post. The hand should not move during the stroke

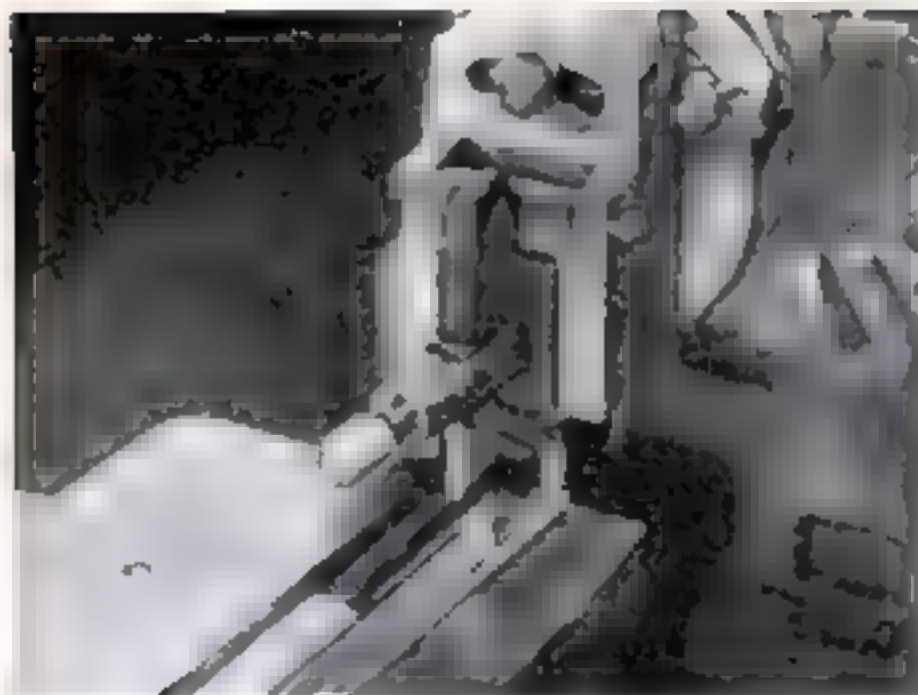
5 One tool is needed for roughing cuts, another for finishing. The former, at left in the photo below, is .200" narrower than the width of the keyway, the other a few thousandths narrower



4 Align the shaft with the sides of the layout the same distance from the corresponding jaws of the vise. A slip of paper under the shaft will remain tight after clamping if the setup is level

6 To be sure the roughing tool is set squarely, rest its cutting edge on a parallel laid on the solid jaw of the vise and keep it there while tightening up the tool-post screw (CONTINUED)





7 With the tool set the table is traversed by hand until the layout marks of the keyway are under the tool. Then the tool is centered with a .100" margin on each side for the finishing cuts



8 Here the ram speed is set for 1 stroke per minute, the lowest speed on the machine shown. This slow speed is necessary because of the shape of the tool used and the type of cut to be taken



9 The ram stroke is set next. Since the keyway is to be 3" long, the stroke should be about 4". On this shaper a crank turns a scale to the setting; on others the scale is on top of the ram



10 The position of the stroke is set manually with the aid of a crank. There should be a 1/4" overrun at the start to give the operator time to change the feed, and a 1/4" overrun at the end

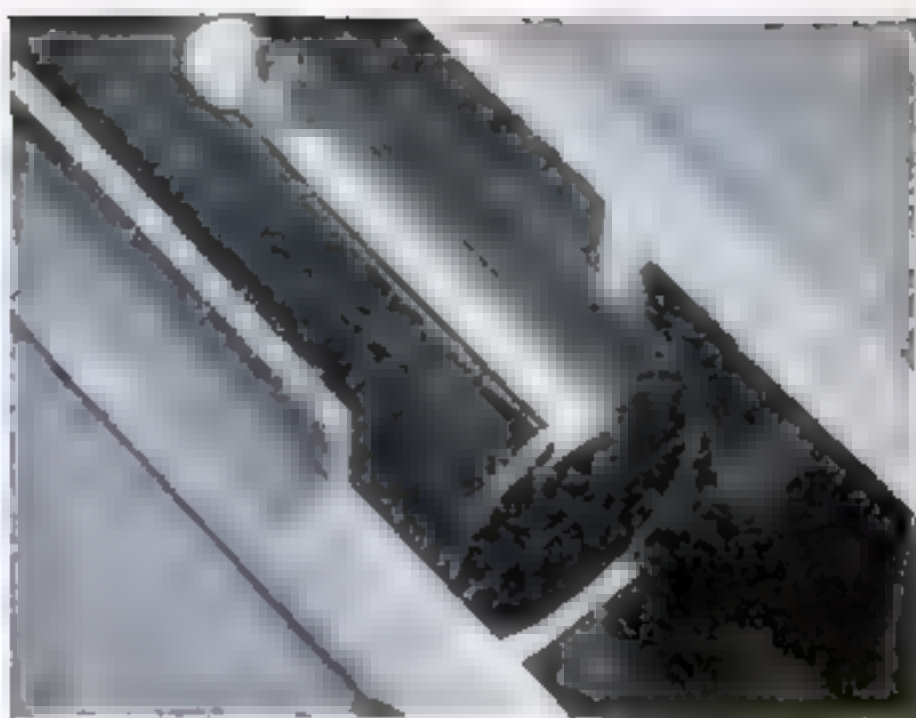
11 Before lowering the tool for the first cut, move the ram back and forth several times as a check. Feed .002" at the end of each stroke by tapping the handwheel with the heel of your hand

12 Stop the shaper after the first roughing cut and check the cut with the keyway layout on the shaft. Note in the photo below how the lines at the sides are still visible alongside the cut





13 Chips collect in the drilled hole at the end of the keyway and block the clearance unless they are cleaned off. Use a brush or magnetized rod, and be sure to stop the ram to avoid injury



14 Remove all chips after the last roughing cut and check the depth with a steel rule placed on the parallel the shaft rests on. Measure from the bottom of the shaft to the bottom of the cut



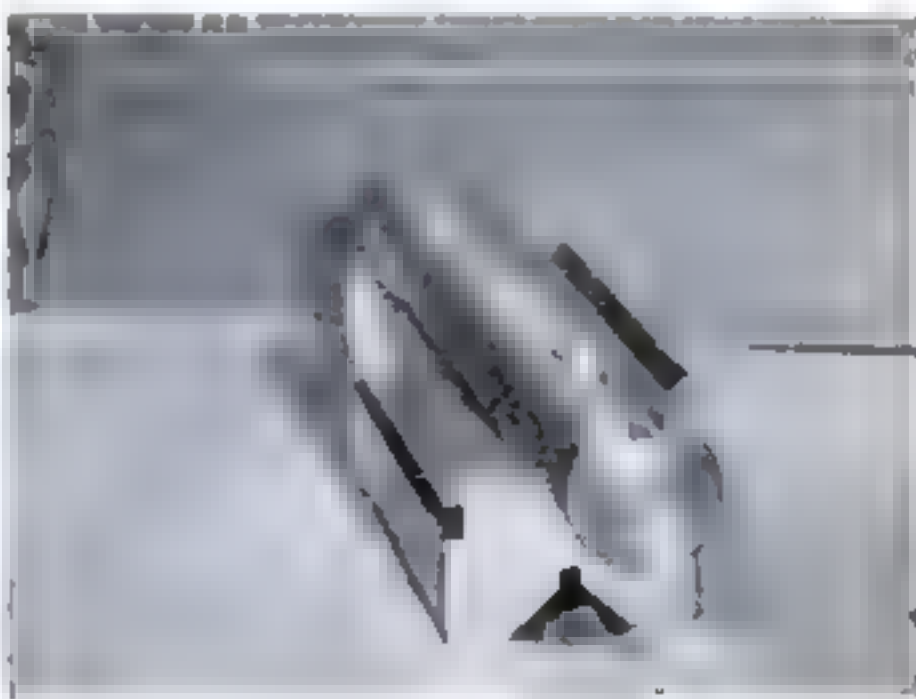
15 Mount the finishing-cut tool loosely in the tool post and rest its cutting edge on a parallel bar set on the solid jaw of the vise. With the edge flush, tighten the tool-post screw



16 Traverse the table until the layout lines are aligned with the corners of the cutting edge of the tool. For a tight-fitting key, the tool corners ought to be a few thousandths inside these lines

17 Ram speed and length of stroke for finishing the edges of the keyway remain the same as for the roughing cuts, and manual feed may also be .002". If desired, scrape the bottom lightly

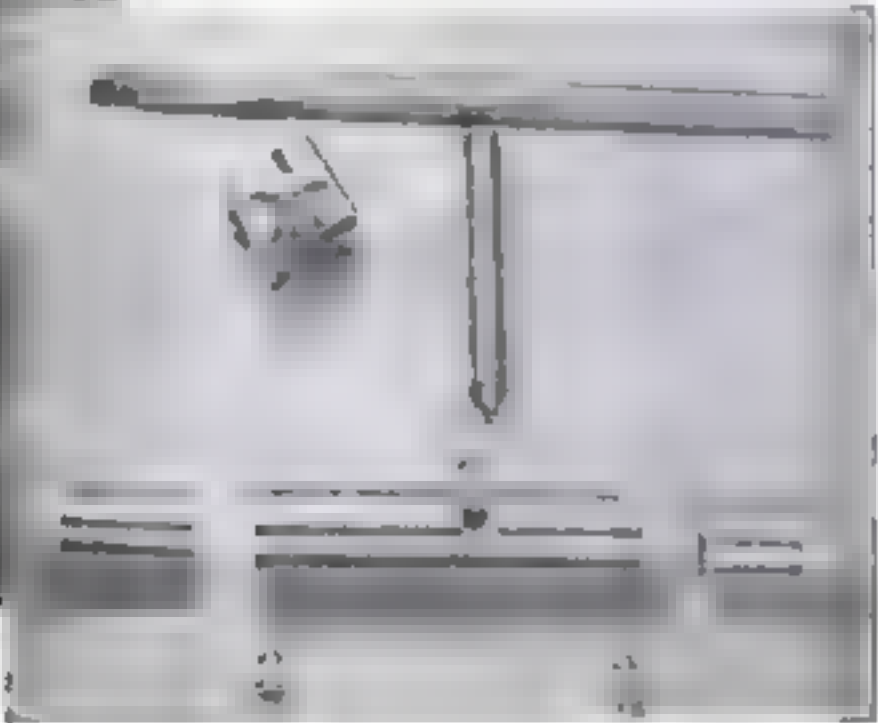
18 Before removing the shaft check the width and depth of the keyway, for once removed it would be difficult to reset the piece in the vise for correcting errors. Here is the finished job



Scale-Reading Telescope Aids Shop Precision



Mounted so that it advances with a lathe carriage, the telescope makes it easy to do accurate boring to a definite depth. All the metal parts of the instrument are shown below before assembly. The locking block was furnished by a dial indicator.



By ERVIN WALTERS

HALFWAY between a telescope and a microscope, a scale-reading telescope is highly useful in many shop applications involving minute movements or exact distances. The one shown, made of brass scrap and three inexpensive lenses, has a working distance of 3" to 4", measured from the objective (front) lens. Magnification can be varied by changing lens position, and the maximum power with the lenses specified in the drawing is approximately six diameters. This optical system gives a reversed image, which is usually not objectionable.

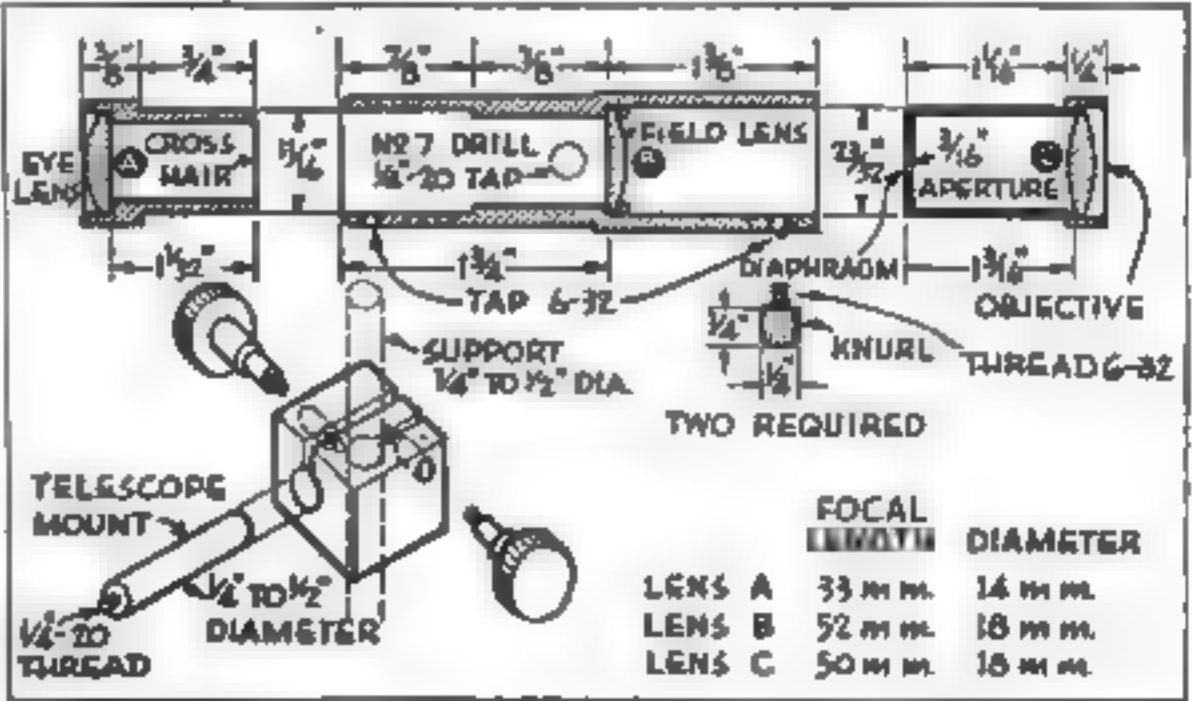
The eyepiece, made up of lenses A and B, resembles a Huygenian ocular, though for a true Huygenian, the focal length of B should be three times that of A, and the distance AB should be twice the focal length of A. The cross hair—either a silk strand, a very fine wire, or a bit of spider web, affixed with dabs of household cement—must be in the sharp focus of lens A. The diaphragm shown is not absolutely essential; it sharpens the image but reduces illumination. All inside surfaces of the telescope are painted a nonreflecting black.

A locking block and two rods about 3/8" in diameter comprise the mounting. One rod, 3" long, is threaded to fit the 1/4"-20 threaded hole in the side of the tube. The other is 6" long and is fastened to a C-clamp, a heavy

metal block, or to some part of a machine tool. The two knurled-head 6-32 screws in the tube hold the inner lens tubes in position; the upper one locks the cross hair in alignment with any scale marks used.

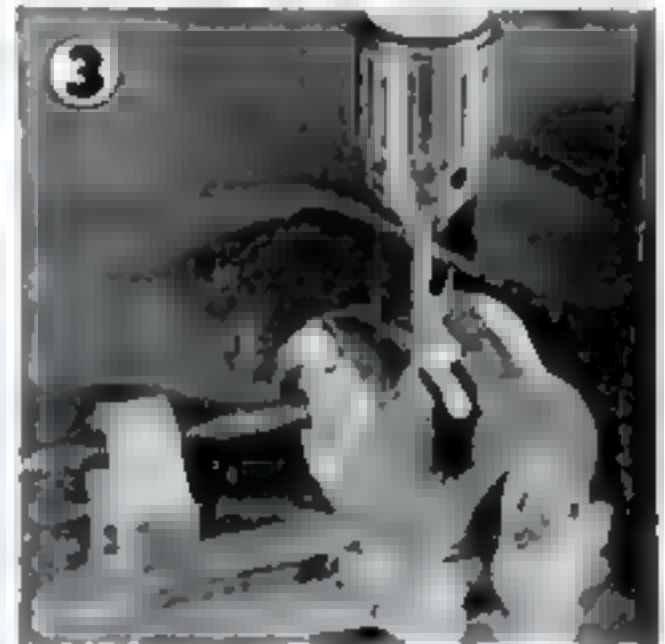
The instrument should always be focused so that, when you move your eye back and forth over the eyepiece, the cross hair and scale line or other index mark appear to move as one. If they move at different rates, the telescope is either not properly focused or the cross hair is not located correctly.

Convenient uses for this telescope include precision boring with a scale attached to the lathe bed and the instrument on the carriage; cutting off exact lengths; measuring diameters of awkward work, with the instrument mounted on a slide rest or milling-machine table; and inspection.



Principal dimensions are shown above. Note the lens specifications.

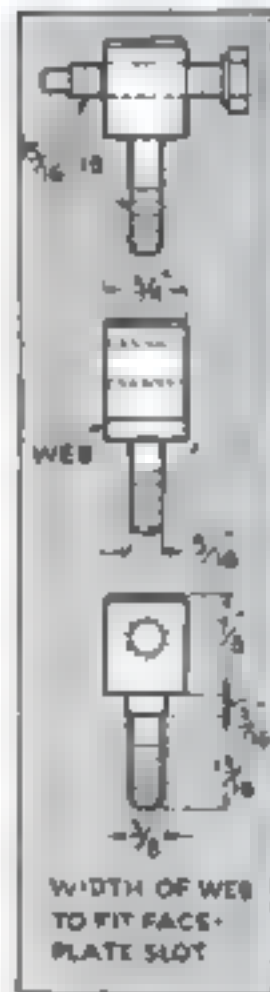
Four Useful Faceplate Dogs Simplify Many Lathe Setups



ALTHOUGH largely supplanted by the four-jawed chuck, the faceplate dog is still a valuable accessory in certain faceplate setups where side pressure with accuracy of adjustment is desired. A set of four of these dogs can be easily turned out for use on a small lathe equipped with an 8" faceplate with $\frac{1}{4}$ " slots, as shown in Fig. 1.

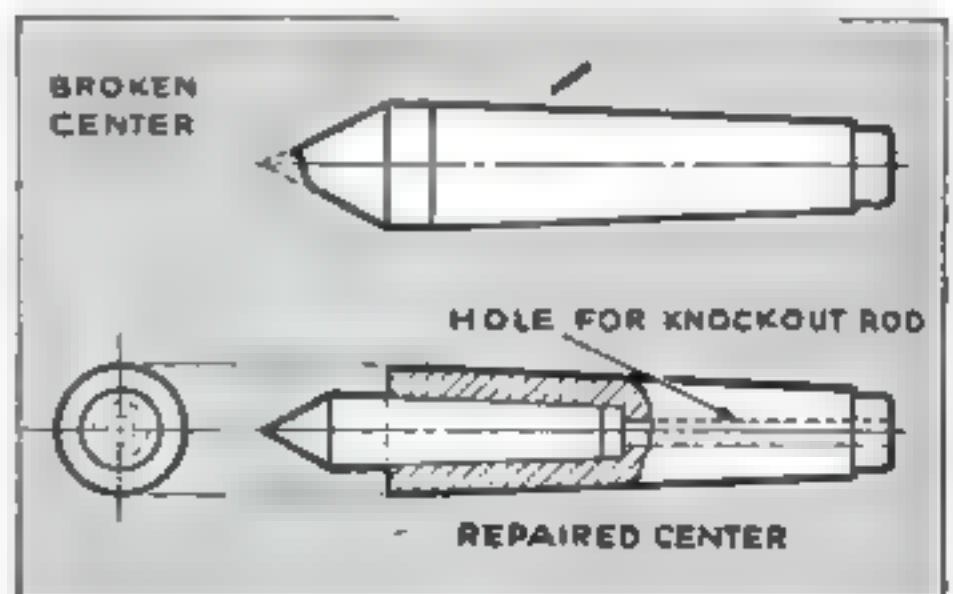
The stock is $\frac{3}{4}$ " square cold-rolled steel chucked as in Fig. 2, which shows the tailpiece being turned. Use an ordinary die to thread the tailpiece for the clamping nut. Then cut off the part, reverse it in the chuck, and smooth and slightly chamfer the head.

Next drill the hole for the adjusting screw (Fig. 3) and tap it 5/16"-18 to receive a cap screw, which can be used with the end square or shouldered as in the drawing. Add washers and screws to four such fittings, and the set is ready for use (Fig. 4).—C. W. WOODSON.



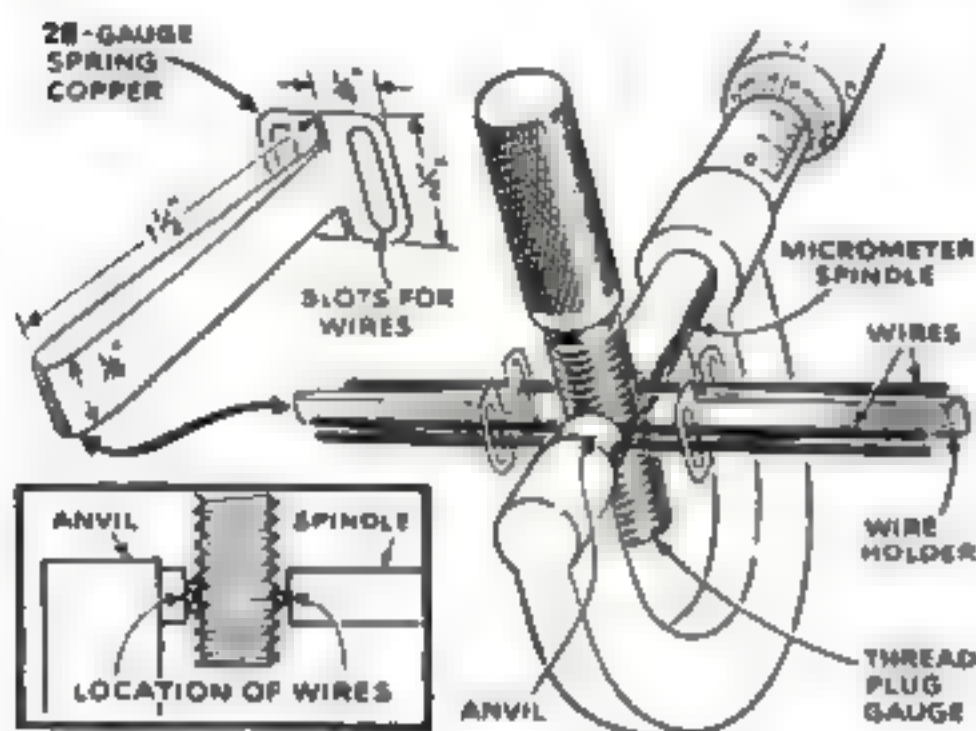
Broken Lathe Center Salvaged with Part of Old End Mill

WHEN a lathe center has been broken, as at right, it can be restored to working condition with stock from a discarded end mill. Anneal the center and machine off the old point square with the shank, and in the shank bore a Morse taper to take the stem of the new point. Next drill the shank with a $\frac{1}{4}$ " hole for a knockout rod. Anneal the end mill and turn it between centers to fit the tapered hole. Put the old center in the spindle, insert the new shank, and turn a 60-deg. point on it. Harden this, then replace and grind it.—H. D. Chapman.



SHOP IDEAS

BLUEPRINT CORRECTIONS can be made in the most legible manner by using a bleaching agent, rather than ink, to write in an omitted dimension. One such agent is a water solution of sodium carbonate—washing soda. Applied with an ordinary pen, it bleaches away the blue color, leaving a highly visible yellowish line.—W. E. B.

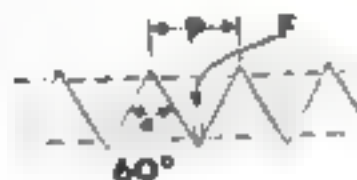
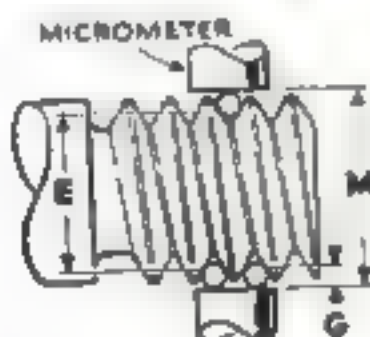


When three wires are used to measure screw-thread pitch diameters, copper springs will hold the wires in place

CHECKING THREAD PLUG GAUGES by the three-wire method of measurement is often complicated by the difficulty of grasping the wires, the gauge, and the micrometer. As shown at the left, however, the job is facilitated by employing a fixture made of 28-gauge spring copper, which will accommodate threads up to $1\frac{1}{4}$ " in diameter. The slots in the springs are made wide enough to take wires up to $\frac{1}{8}$ " diameter and long enough to provide for different pitches. By placing the wires through the slots and in the threads of the gauge as illustrated, accurate measurements can be made more quickly than by holding them with rubber bands. Hold the anvil of the micrometer against the two wires.—H. D. CHAPMAN.

THREE-WIRE THREAD MEASUREMENT

[SHOP PRACTICE]



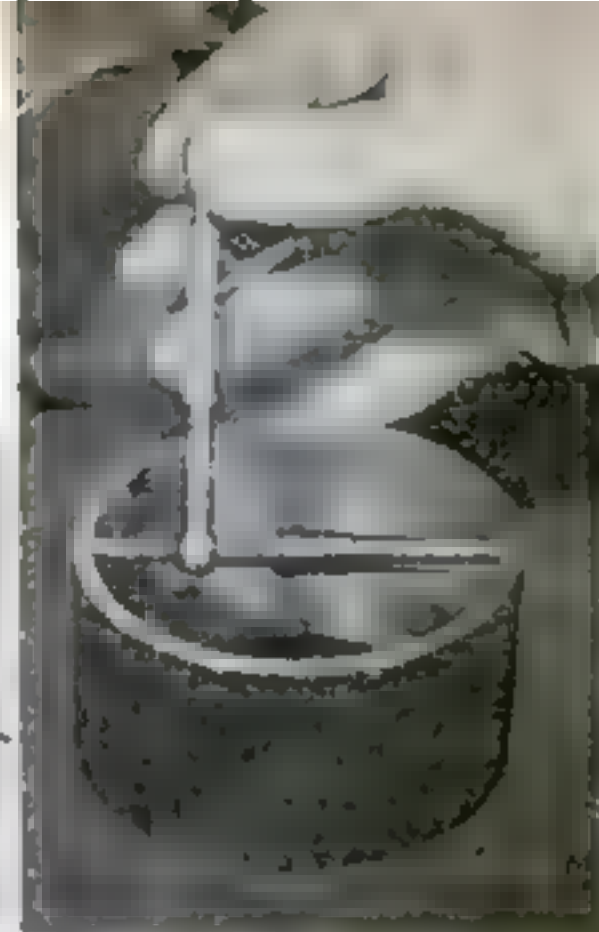
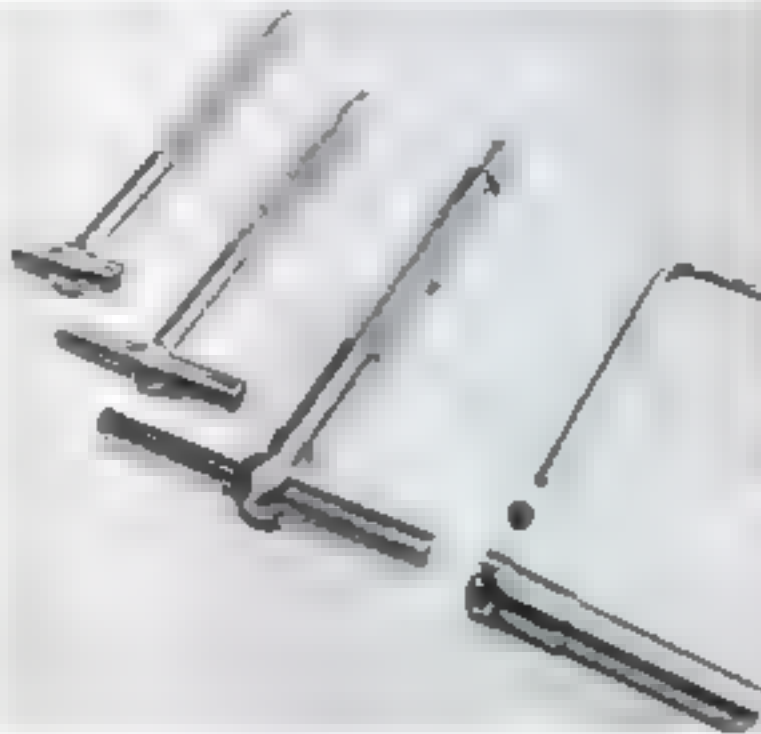
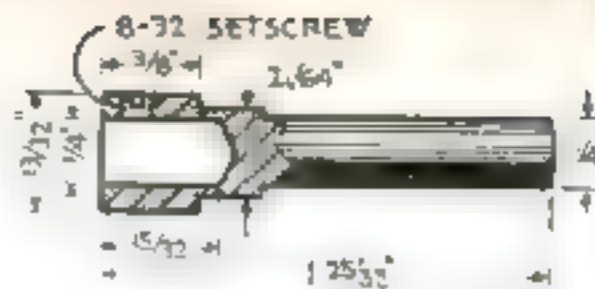
Standard threads are truncated. The flat is one eighth the pitch

In computing the measured pitch diameter of any screw, the formula is $E = M - \frac{1}{N} \cot \frac{\alpha}{2}$, in which M equals the measurement over P the pitch diameter, G the diameter of best wire, N the number of threads per inch, and α one half of the included angle of thread. For a 60 deg thread, either American or British or National fine, the formula is $E = M - \frac{0.86603}{N}$, and because 30 happens to be just twice $\frac{0.86603}{N}$ this formula can be simplified to $E = M - \frac{0.86603}{N}$. Best wire is defined as the size of wire that touches exactly at the mid-slope of a thread. The accuracy of the wire must be three times the desired accuracy of the measurement. A table of best wires follows.

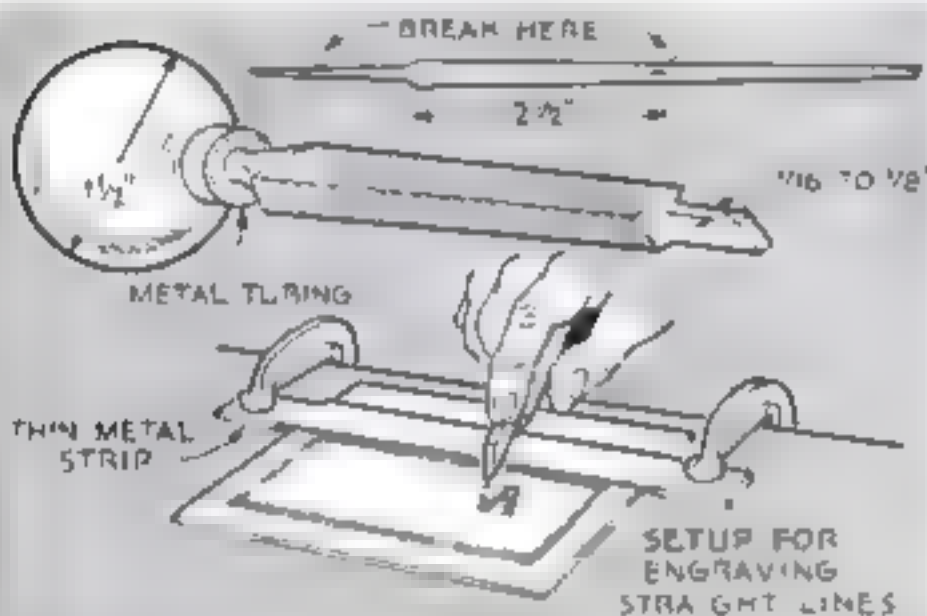
N Threads Per Inch	$G = \frac{0.86603}{N}$ Dia. Best Wire	N Threads Per Inch	$G = \frac{0.86603}{N}$ Dia. Best Wire	N Threads Per Inch	$G = \frac{0.86603}{N}$ Dia. Best Wire
16	0.05412	24	0.03604	13	0.06661
18	0.04811	26	0.03331	14	0.06188
20	0.04330	28	0.03093	16	0.05412
22	0.03936	30	0.02887	18	0.04811
24	0.03604	32	0.02706	20	0.04330
26	0.03331	34	0.02547	22	0.03936
28	0.03093	36	0.02405	24	0.03604
30	0.02887	38	0.02273	26	0.03331
32	0.02706	40	0.02165	28	0.03093
34	0.02547	42	0.02062	30	0.02887
36	0.02405	44	0.01970	32	0.02706
38	0.02273	46	0.01883	34	0.02547
40	0.02165	48	0.01804	36	0.02405
42	0.02062	50	0.01732	38	0.02273
44	0.01970	52	0.01665	40	0.02165
46	0.01883	54	0.01607	42	0.02062
48	0.01804	56	0.01554	44	0.01970
50	0.01732	58	0.01505	46	0.01883
52	0.01665	60	0.01463	48	0.01804
54	0.01607	62	0.01425	50	0.01732
56	0.01554	64	0.01391	52	0.01665
58	0.01505	66	0.01360	54	0.01607
60	0.01463	68	0.01332	56	0.01554
62	0.01425	70	0.01307	58	0.01505
64	0.01391	72	0.01284	60	0.01463
66	0.01360	74	0.01263	62	0.01425
68	0.01332	76	0.01244	64	0.01391
70	0.01307	78	0.01226	66	0.01360
72	0.01284	80	0.01210	68	0.01332
74	0.01263	82	0.01195	70	0.01307
76	0.01244	84	0.01181	72	0.01284
78	0.01226	86	0.01168	74	0.01263
80	0.01210	88	0.01155	76	0.01244
82	0.01195	90	0.01143	78	0.01226
84	0.01181	92	0.01132	80	0.01210
86	0.01168	94	0.01121	82	0.01195
88	0.01155	96	0.01111	84	0.01181
90	0.01143	98	0.01101	86	0.01168
92	0.01132	100	0.01092	88	0.01155
94	0.01121			90	0.01143
96	0.01111			92	0.01132
98	0.01101			94	0.01121
100	0.01092			96	0.01111

POPULAR SCIENCE MONTHLY SHOP DATA

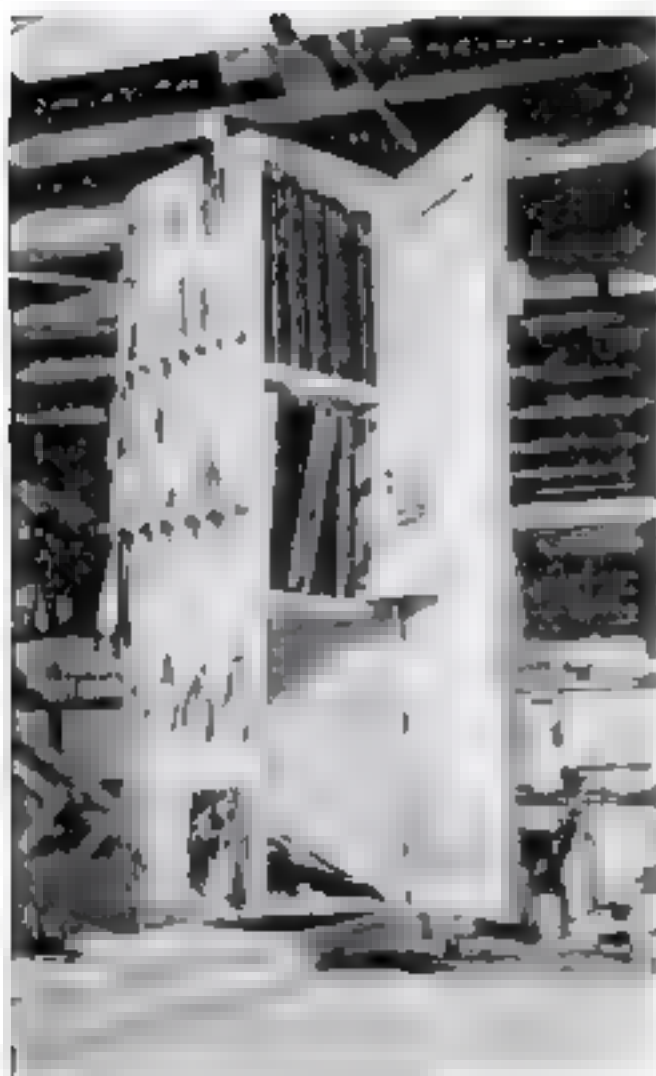
GREATER RANGE is given a telescoping gauge by fitting its sleeve with an extension turned from tool-steel rod and rounded on the end to a radius less than that of the smallest work to be measured. The extension shown was designed for a gauge measuring inside diameters of from $1\frac{1}{4}"$ to $2\frac{1}{2}"$ and increases its range to a maximum of $3\frac{7}{16}"$. It leaves a gap between $2\frac{1}{8}"$ and $2\frac{9}{16}"$, but since $\frac{1}{8}"$ is standard sleeve diameter, the extension can be used on a smaller gauge to fill this gap. Extensions of several lengths permit a variety of measurements with a small set of gauges and, if desired, two or more may be fitted end to end. The solid end is hardened to resist wear.—W. E. B.



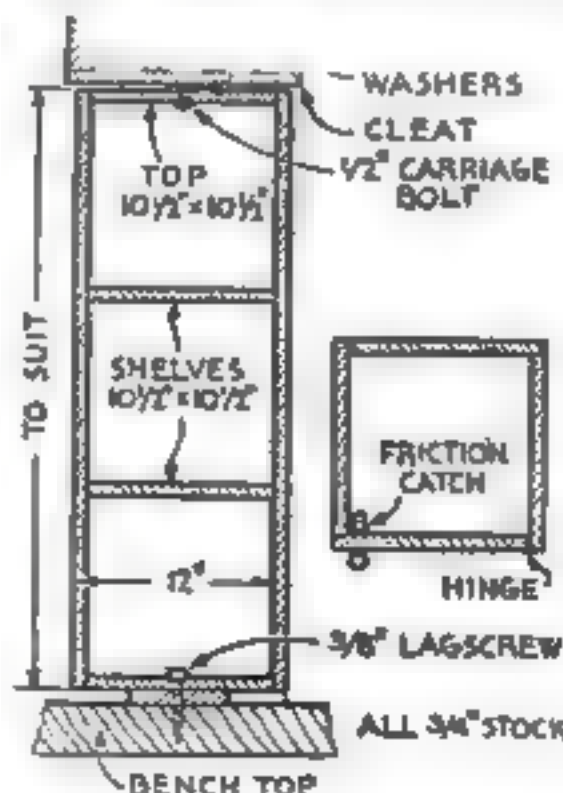
Supplemented by this simple extension, a small set of gauges measures many sizes of inside diameters



ENGRAVING ON METAL can be done with an old file, broken and ground as shown and equipped with a handle to fit the palm of the hand. A slender taper file is best, but other types are satisfactory. Polish the surface to be engraved and lay out the design in pencil; then apply considerable pressure to the tool, twisting it from side to side and making it "walk" as it works. When required, a thin metal strip clamped to the work will serve as a straightedge, as shown in the drawing at left. The tool may be used for engraving brass, copper, nickel, pewter, aluminum, and even tin cans.—R. S. W.



LIGHT TOOLS ARE CLOSE AT HAND on this revolving tool rack and cabinet that can be mounted between the bench and a basement-workshop ceiling. Racks for frequently used small tools are provided on the four sides, one of which is hinged to give access to a shelved compartment that will keep books and shop notes out of the dust. Types



of racks should be chosen to suit the tools they will hold. If any are to be screwed on from the inside, it may be more convenient to do so before final assembly to avoid having to work in close corners. The shelves will serve as cross members to brace the sides, but if lighter stock than the $\frac{3}{4}"$ specified is preferred, extra bracing may be needed. If turning is hard, a washer can be inserted at the bottom.—WILLIAM FREEMAN.



From "The Kite That Smashed Berlin" in the March, POPULAR SCIENCE

Back Lighting

PUTS DRAMA INTO YOUR PICTURES

By Walter E. Burton

COMMON causes of uninteresting photographs, or failure to get a picture at all, are flat lighting and incorrect exposures resulting from attempts to get pictures with some other kind of lighting. In photographic parlance the term "flat lighting" means that most or all of the light illuminating the subject comes from a point approximately in line with and behind the camera.

Thus when you stand with the sun directly behind you and snap a picture, you are employing lighting that is flat. The picture looks flat and weak because shadows

that give the subject roundness and detail, are cast directly away from the camera lens. Even when there are shadows, the subject sometimes merges with the background so much that it loses its importance in the picture.

A powerful remedy for weak pictures is back lighting. In a back-lighted picture, much of the light comes from a point that is more nearly behind the subject than it is behind the camera. Such lighting pepes up a picture surprisingly, giving the main subject roundness, depth, and emphasis.

An example of back lighting carried to the ultimate is the silhouette photograph.

The main object is seen in outline against a light background, and the side of the subject toward the camera is black and totally devoid of detail. Often the stunt of photographing the subject in outline against a sunset or other light background will make it possible to get a picture where other methods would fail.

When making silhouettes, expose for the background instead of the subject. You can make such pictures at any time and with any equipment. On the most brilliant day you can pose the subject in a doorway, with a lake or open landscape behind, and expose for the landscape. Or you can shoot an outdoor scene through an archway or through an arch formed by tree trunks and branches. Nearby objects will be black or nearly so in the picture.

The true silhouette method is limited in its application. More often you want to know what the camera side of the main subject looks like. Here is where true back lighting comes in. This calls for strong illumination back of the subject and casting strong shadows toward the camera. The light source may be placed so the shadows are thrown directly toward the lens; but a more pleasing result usually is obtained when the shadows are cast at an angle.

With only the back light you still would get a silhouette effect because of the loss of front detail. Therefore it is necessary to have some diffused light striking the camera side of the subject.

Back-lighted outdoor pictures are easy to make in sunlight. Place the subject somewhere between the cam-

era and the sun so that shadows will be thrown forward. Usually there will be enough light from the sky reflected by the foreground to show details of the subject.

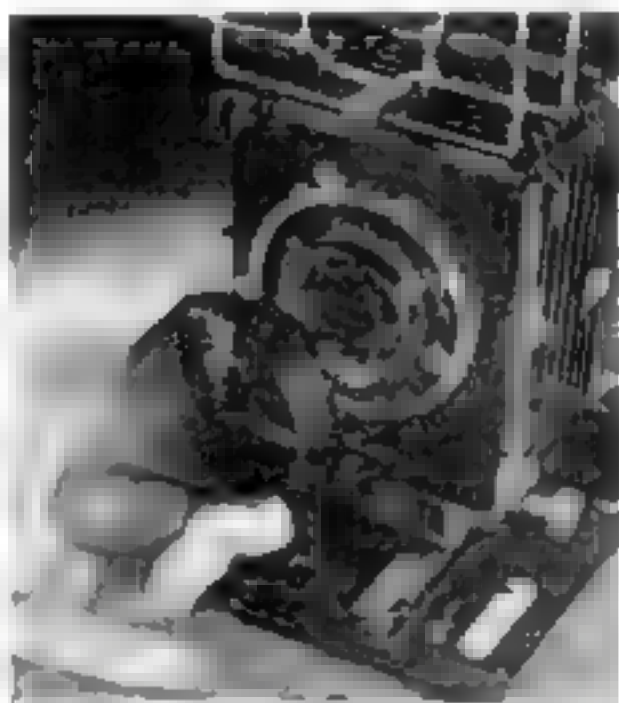
Some positions of the sun with respect to the subject are better than others. In most cases the sun should be fairly high in the sky, so that its light will strike the subject at a high angle. This brings the complete shadows within the field of view and prevents stray light from entering the camera lens.

Stray light is important. If you point a camera toward the sun, even though not directly at it, strong light entering the lens may fog the film and sometimes produce ghost images. To prevent this, use a sun shade. Such a gadget is merely a short cylinder or cone of metal or other opaque material that is slipped over the front of the lens. It sticks out far enough to intercept all rays not contained within the angles of view of the lens.

The exposure for back-lighted pictures is

generally a simple matter to determine. One method is merely to expose the film four times as long as you would with a light of the same light intensity behind you. For instance, if your exposure meter indicates that the exposure for a subject in outdoor sunshine is 1/200 second at F/11, you would use 1/50 second at F/11 when photographing the shadow side of the subject. Another method is to direct your meter at the camera side of the subject while shielding it from the direct rays coming from behind the subject.

When you cannot depend



Although a shade on your lens is not always essential, it reduces the risks of fog or ghost images





Photo by Michèle de Santis

on normal light from the sun or sky to bring out details on the shadow side of a back-lighted subject, you must supply additional light. This can be done with a piece of white cardboard or cloth arranged where it will reflect diffused light toward the subject.

With photoflash lamps and a good synchronizer, you can widen the scope of your back-lighting technique and even take pictures of a figure against a sunset. When using photoflash lamps in daylight, you have to balance one light against the other in determining shutter speeds and lens stops. This boils down to a matter of distance between flash bulb and subject, since exposure at a given lens stop and shutter speed depend on distance.

First of all determine the correct exposure for the daylight—the exposure that will show the background with proper tone value and that will record the back-lighted details. This exposure is produced by a certain shutter speed at a particular lens stop. Thus you can select a shutter speed that will enable you to stop motion, if any, and to operate the synchronizer. (Some cameras should be synchronized at 1/100 second or faster for reliable results.) From a table of flash-bulb exposures, select a distance from lamp to subject that will give a correct photoflash exposure for the shutter and lens stop used.

Probably this sounds involved, so let's

see how it works out in a specific example:

Subject: A fisherman walking home along a path, the sun behind him and fairly low in the sky.

Camera position: Ahead of the fisherman, and to one side of the path, to show his face and his right side.

Correct exposure for background area: 1/100 second at F/8. This is insufficient exposure, however, to show much detail in the fisherman's face, clothing, and paraphernalia, other than parts back-lighted by the sun.

The camera is fitted with a synchronizer, and you have a 40,000-lumen photoflash lamp. From a table of lamp distances, you find that a 40,000-lumen lamp will give the right illumination at about 22' with a shutter speed of 1/100 second and a lens aperture of F/8. The picture thus obtained will show not only the background and back-lighted part of the subject fully exposed, but the foreground and camera side of the subject as well.

Sometimes the open-flash method may be used when back lighting is weak. Set the camera shutter on "time" or "bulb," open it for an interval sufficient to record the background areas and, during this interval, fire the flash bulb. Most ordinary flash bulbs produce usable light for about 1/50 second.

Back lighting will be found highly useful to the photographer who tackles the job of photographing still-life objects by artificial

light. A simple lighting layout using incandescent lamps consists of:

1. A 500-watt spotlight for back lighting the subject. Place it behind the subject, but not necessarily directly in line with the lens, and at whatever level above or below the camera the subject and its position require.

2. A No. 2 photoflood or 500-watt lamp in a good reflector, placed near the camera and moved back and forth to obtain the correct intensity of front lighting.

3. Possibly a smaller lamp, such as a No. 1 photoflood in a portable, clamp-on reflector, used to throw modeling light on the camera side of the subject when a single lamp produces illumination that is too one-sided.

In using an exposure meter, turn out the spotlight and read only the intensity of light on the side of the subject toward the camera.

Either orthochromatic or panchromatic film can be used for back lighting. The "pan" film is probably better for all-around use because it is more sensitive to the yellow-red light encountered in late afternoon and early morning silhouette work and in photoflash and incandescent-lamp photography. A fast film is desirable. Back lighting increases contrast, so be careful not to overdevelop your negatives. And for the same reason, you probably will find that rather soft paper is best for mak-

ing prints, say No. 1 or No. 2, although silhouettes may be best on No. 4.

The next time you unlimber your camera, try some back-lighted shots and note how three-dimensional they seem. With color film the same principles will apply, as they also will with home movies, except for the rules involving the use of flash bulbs.



Photo by Michele de Santis



With space at a premium in a house trailer, this homemade enlarger is necessarily compact, though without sacrifice of efficiency. The string beside it at the left is connected to the light switch. Pictured above are the parts; at right, a close-up



THIS COMPACT ENLARGER, built for use in the cramped quarters of a house trailer, is made chiefly from a cigar box, a piece of opal glass, two lengths of plate glass, a cylindrical cardboard container, and an enlarging lens.

A 60-watt, 110-volt enlarging bulb in the dome light recessed above the trailer sink forms the light source. Under the cabinet holding this light two tracks are screwed to receive flanges on the negative-holder housing. The latter, constructed from a cigar box, has a hole in its floor somewhat larger than the negatives to be enlarged. Two slots permit a glass "sandwich-type" negative holder to be slid through the box, while the opal glass is mounted on wooden spacers.

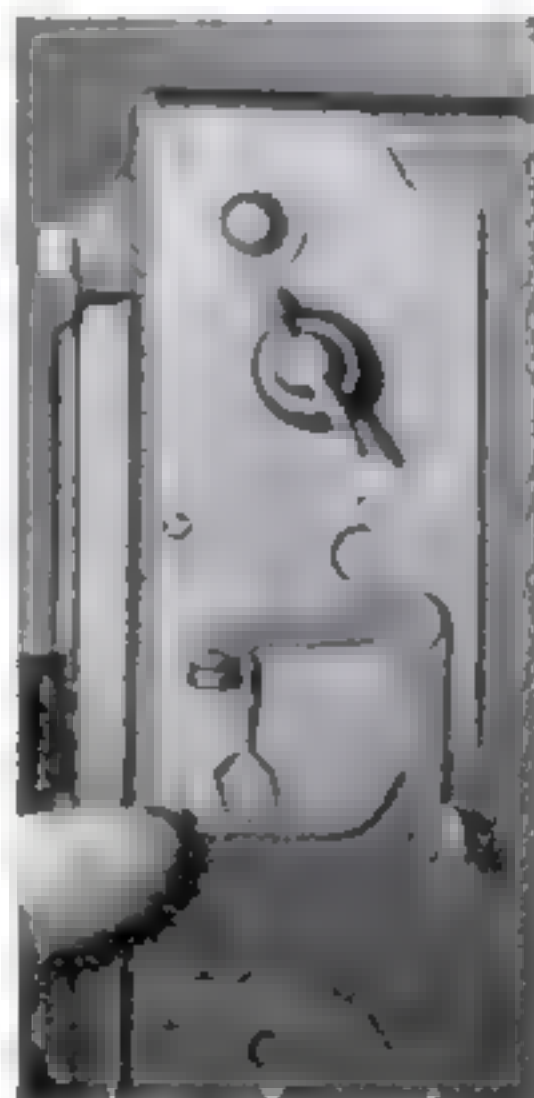
Glued beneath this housing is a cardboard drawtube cut from a cereal container. Since a second tube must fit snugly but adjustably over it, several layers of cardboard were peeled off to reduce the diameter. (Another way might have been to cut a narrow lengthwise strip from the tube, and then to glue a butt strip inside.) The lens cell is built up from cardboard and thin wood, and is glued to the second, outer drawtube.

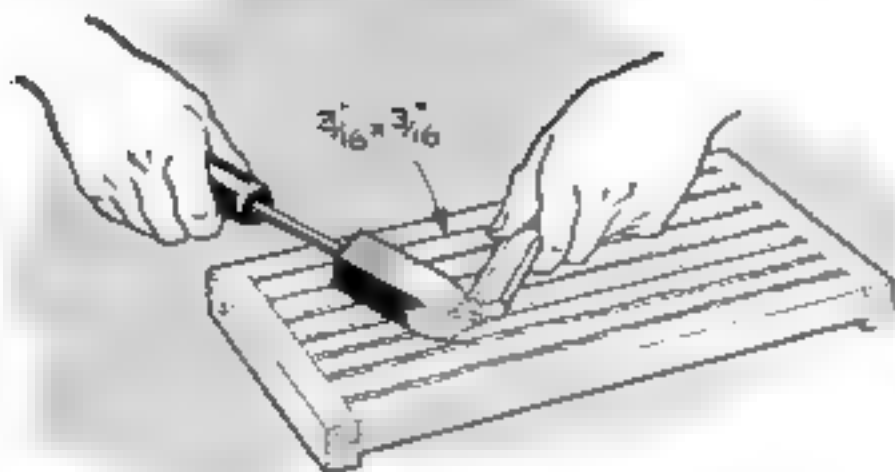
All inside surfaces are blackened with ink, and black cloth is glued to apertures that might leak light. Since negatives remain at a fixed height, the degree of enlargement is varied by placing books or boxes of different thicknesses beneath the easel.—MANLY BANISTER.



TELESCOPING TRIPOD LEGS may be held in any desired location between the regular stops if a few rubber bands are snapped tightly around each leg, as at the left. The outer sections of the legs are then pushed down against the bands. When the tripod is to be closed, the bands may be rolled to the foot of the legs and kept there for future use.—WILLIAM SWALLOW.

FOCAL-PLANE SHUTTERS can be locked in an open position by means of a simple wire clip, as at the right. In cameras having both focal-plane and between-the-lens shutters, it is of course necessary to leave the former open when you are working with the between-the-lens shutter, or else blank negatives will result. Even though the shutter is left open, it may be inadvertently snapped shut. The clip prevents this; it should be bent to hold the lever tightly against the cable-release lug.—LOUIS HOCHMAN.

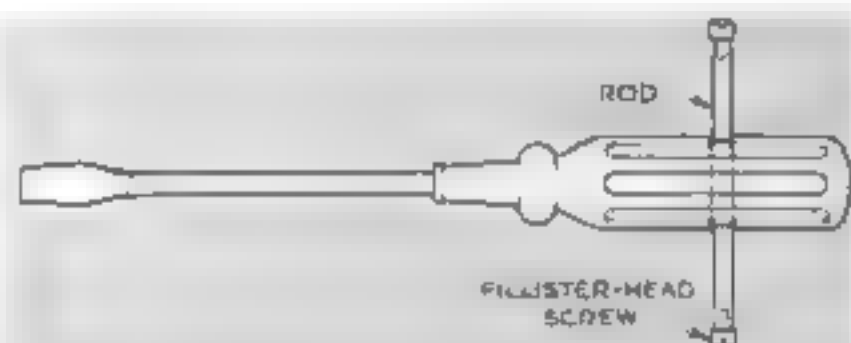




HANDY TROUBLE LIGHT. A lamp for emergency use around a car, motorcycle, or tractor can be made from an old flashlight. Enlarge the hole in the reflector to take an automobile bulb. File off the pins and solder a wire to the center contact at the bottom of the base. Solder another wire to the flashlight case. Attach battery clamps to both wires. Clip the wire from the bulb to the ungrounded battery post or any "hot" terminal, and the other to any bare metal on the frame. When the light is not needed, the wires and clamps can be packed away inside the case.



SOLDER STICKS that serve well in place of wire solder can be made by using a hot copper to melt bar solder into the grooves of a mold like the one at the left. Plow a series of narrow grooves in a hardwood board after rabbeting both ends to fit grooved cleats. The cleats will serve to dam the channels and keep the form from warping under the heat of the solder. Secure them with nails driven into the ends of the board between the grooves.

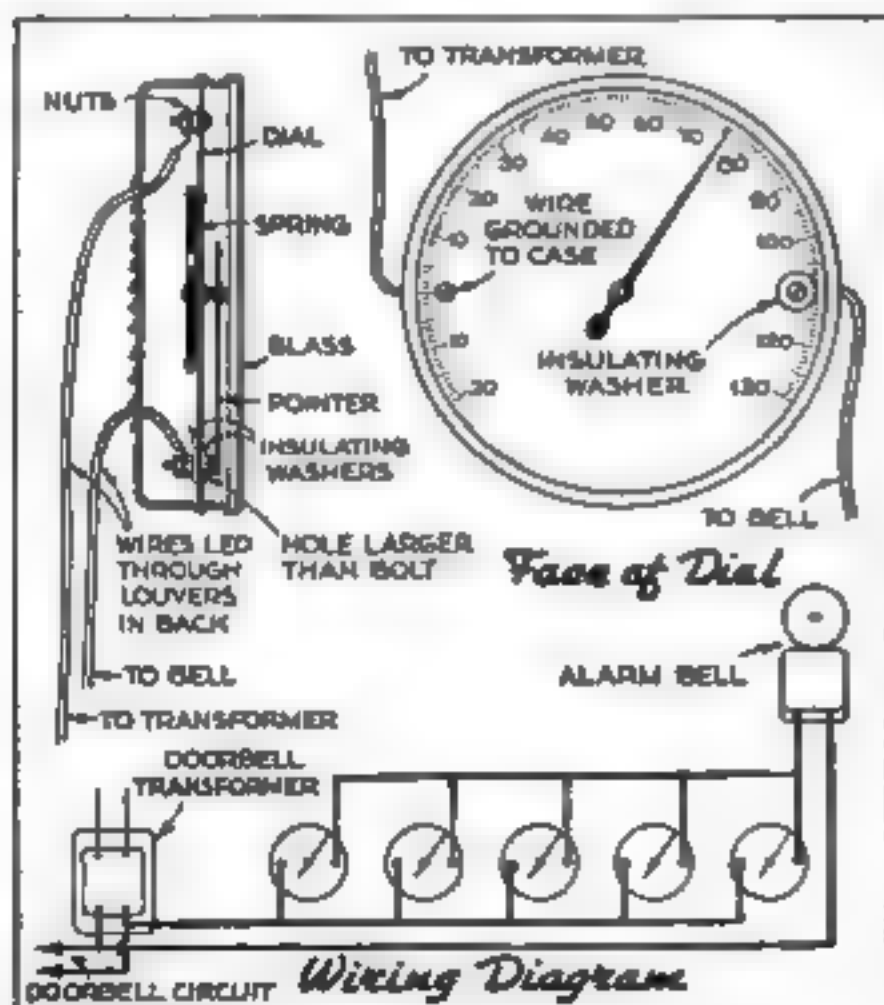


SCREWDRIVER HANDLES bored and fitted with cross rods as in the drawing above will provide increased leverage for turning stubborn screws. Both ends of the rod are tapped for fillister-head screws, one of which can be taken out to remove the rod when it is not needed.—CARL KNUTSEN.

SOLDER WON'T ADHERE to a surface that has been coated with a mixture of charcoal and glue thinned with water until it can be spread easily with a brush. After soldering, the dried coating can easily be removed with a wire brush.—W. E. B.

A HOME FIRE-ALARM SYSTEM can be provided at small cost by installing inexpensive dial-type thermometers throughout a dwelling and connecting them in an electrical circuit. As shown in the diagram, one post of the doorbell transformer is connected to an alarm bell, and the other post to the dial of each thermometer by means of a small bolt and two nuts. One nut secures the bolt to the dial, while the other one binds the wire.

At another point on each dial—say at the 110-deg. mark for lower floors and higher in the attic—a second bolt is installed through a hole bored large enough to accommodate it with space all around. This bolt is then insulated from the dial with rubber washers on each side, and is connected to the second terminal of the alarm bell. Since the uninsulated bolt in each dial makes electrical contact with the pointer, the circuit will be closed and the alarm will ring whenever the hand reaches the insulated bolt at the point of high temperature.—WILLIAM T. CRUNE.



CYLINDER-LOCK TROUBLES AND

Sticking Pin-Tumbler Locks Are Easy to Repair If You Know What's Inside Them and Work Carefully

By HAROLD P. STRAND

PIN-TUMBLER cylinder locks have long proved efficient safeguards on outside doors, and on inside ones too when special privacy has been important, and for just as long they have intrigued amateur locksmiths who, for the most part, have been too timid to take a look at what makes them work. Fortunately for those amateurs not so timid, these locks rarely get out of order. But when they do, it really is a simple matter to service them if their principle of operation is understood.

Cylinder locks of the pin-tumbler type derive their name from a series of round pins of various lengths that they employ for actuation by the key. If carelessly handled when taken apart, a lock can spill these pins in confusion and present the amateur with a first-rate puzzle.

There are two sets of pins, one in the upper part of the main barrel along with a set

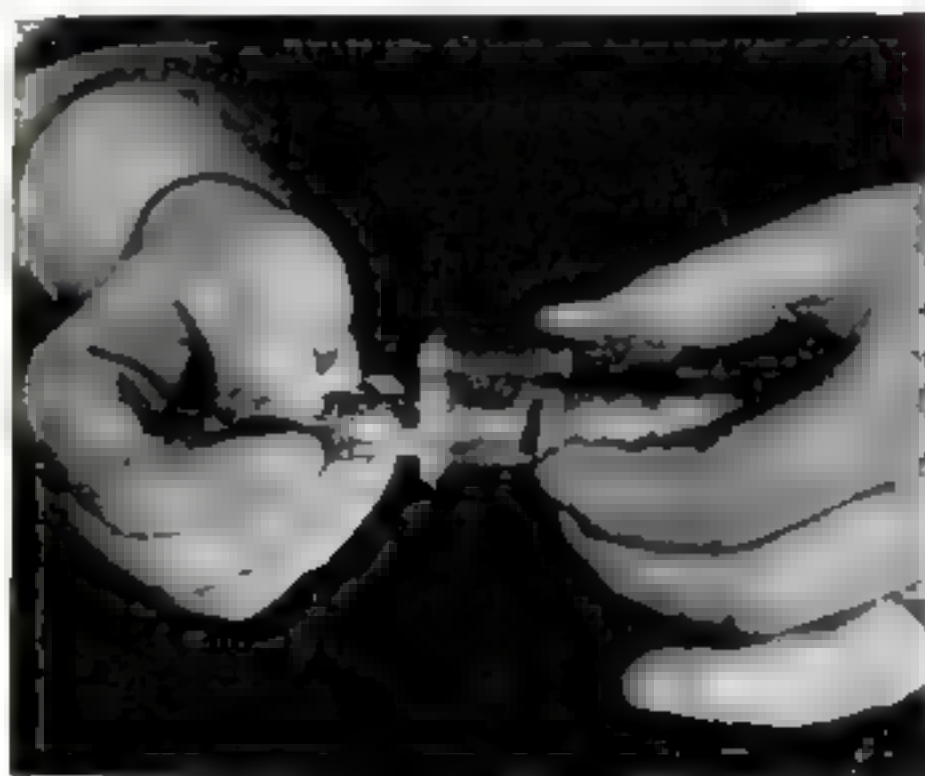


Cylinder locks can be removed for servicing by loosening one screw in the lock plate and unscrewing the barrel with the aid of the key

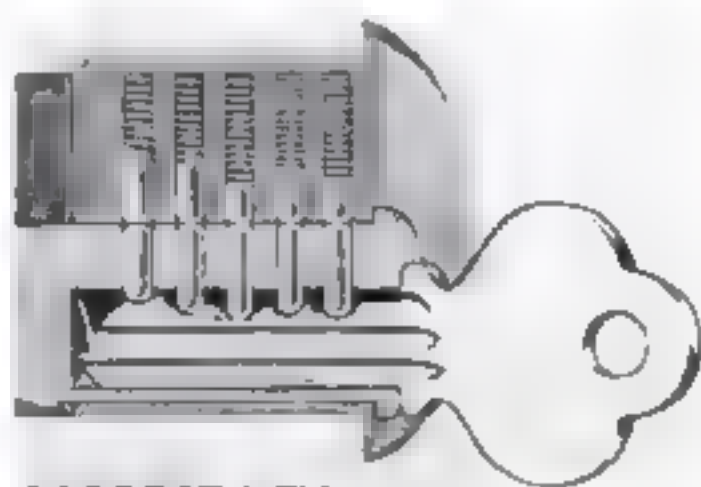
1 On this lock a single screw secures the cam to the cylinder. Once the cam is removed, take care not to let the cylinder slip out of the barrel



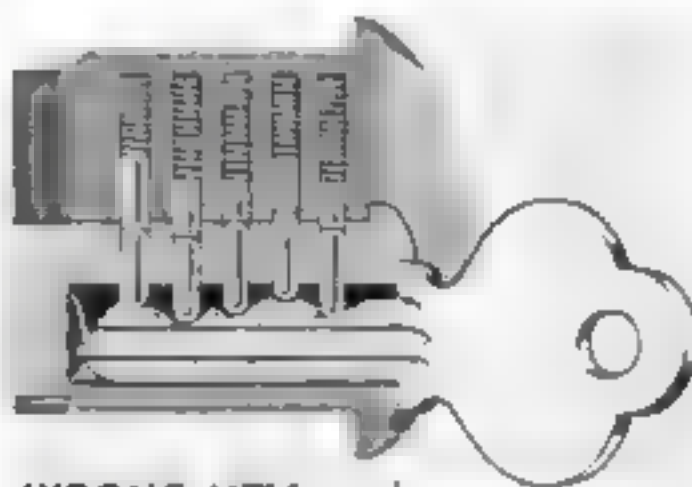
2 Push a short piece of tubing close after the cylinder as you slowly press out the latter. The tube keeps the barrel pins from falling out



WHAT TO DO ABOUT THEM



**CORRECT KEY MAKES
PINS MEET AT SURFACE
OF CYLINDER**



**WRONG KEY CAN'T
ALIGN PINS AND WON'T
TURN**

of tiny coiled springs, and the other in the rotating cylinder or plug. Holes in the two sections of the lock are matched so that, when there is no key in the lock, the upper pins will be pushed part of the way into the lower holes by their springs and thus lock the cylinder to the barrel.

Inserting the right key results in lifting the pins from a shelf-like ridge or ward in the keyhole so that the meeting surfaces of the upper and lower pins line up exactly with the top of the cylinder, which can then be turned. A lever or cam on the back of the cylinder can then be moved by the key and will operate the main lock mechanism and unlock the door. Should a wrong key have wards that permit it to be inserted, it would lift the pins, but they would not line up at the top of the cylinder, and the lock still would not turn, as indicated in one of the drawings above. Five pairs of pins are used in the average house lock, and they can be

varied in length to obtain an almost endless number of combinations.

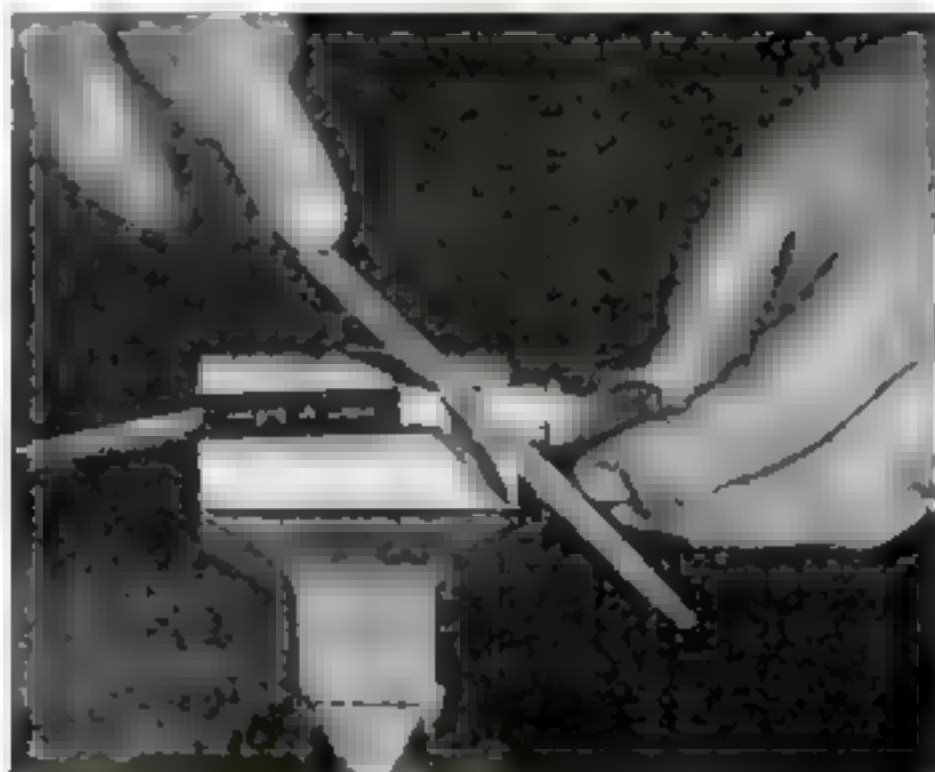
Some cylinder locks employ flat levers for tumblers instead of round pins. This is especially true of some of the cheaper varieties that look on the outside like pin-tumbler cylinder locks. The two types can easily be distinguished, however, by looking into the keyhole, where the first lever or pin can be seen plainly.

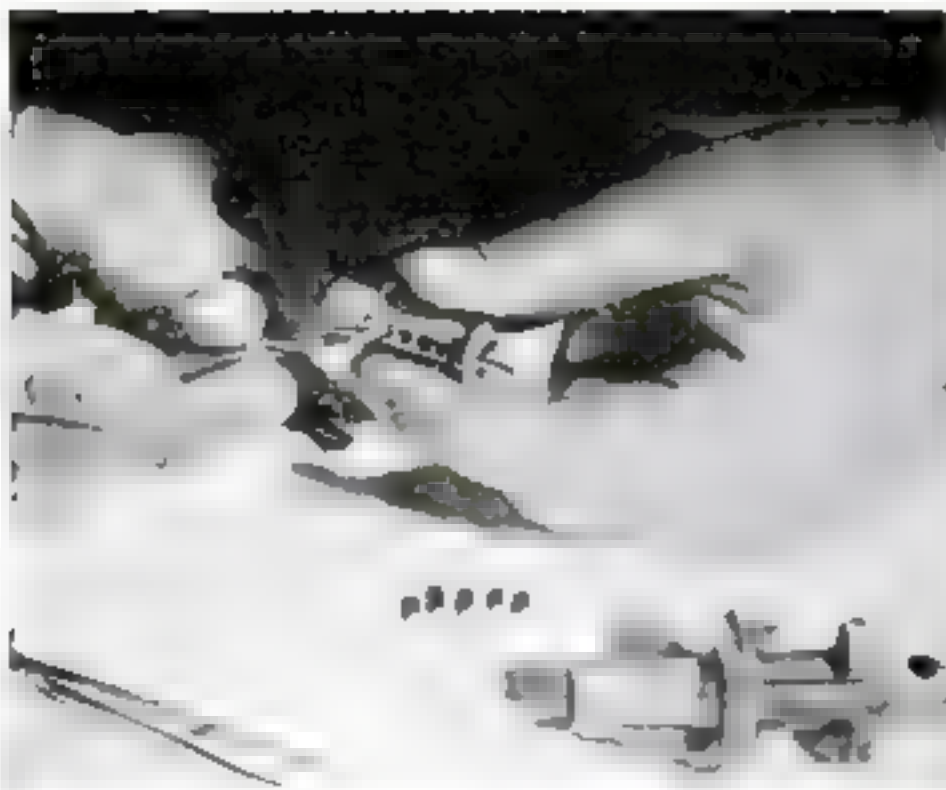
When trouble is experienced with a pin-tumbler lock, the first complaint often is that the key catches before it turns. This is usually caused by wear on the key, on the pins, or on both. It may also be due to sticky pins, a condition that can be remedied by the application of a little powdered graphite blown into the keyhole. After this is done, the key should then be worked in and out a few times to lubricate all the pins. Don't use oil on the pins.

If the graphite treatment fails, loosen

3 Examine the pins in the cylinder with the key in place. All should be flush with the surface of the cylinder. Remove any that are short

4 After new, longer pins have been provided, the cylinder is clamped in the vise and the long pins are filed until they are flush





5 All the pins are next removed and placed in their relative position on the bench, and the holes are slightly countersunk with a drill held in the fingers



6 Each pin is then placed in turn in a small hand drill and the filed end is rounded a bit to remove burrs that might cause sticking

just one of the two machine screws in the plate on the edge of the door (the screw nearest the outside, as shown in the photo on page 180); then use the key, inserted nearly to full position, as a lever to unscrew the barrel. Sometimes a barrel may be hard to start this way and a screwdriver instead of the key will be needed in the keyhole, or some penetrating oil may be applied around the barrel—not inside the keyhole—to loosen corrosion.

At the bench, the first job (Fig. 1) is to remove the back cam or lever. In the lock shown, it was held by a screw. With the cam off, care must be taken not to allow the cylinder to drop out and let the upper pins and springs spill. Cut a 4" length of brass or steel tubing of the same diameter as the cylinder and clamp it in the vise; then insert the key in the keyhole, turn the cylinder in the barrel slightly, and push it out with the tubing (Fig. 2). This holds the upper pins and springs in place. To prevent accidental withdrawal of the tube, wrap a rubber band or cellulose tape around both its ends.

With the key still pushed in to full position, examine the cylinder to see that no pin sticks out too far or fails to come up flush with the surface. Either condition will contribute to sticky operation. It is easy to file down a pin that is too long, but one that is too short will have to be replaced. In fact, a defective one is usually short since both the pins and the key are subject to wear. It is a good idea, therefore, to obtain an assortment of new pins from a locksmith. If you are good at estimating, and do not wish to leave the lock out of service while you make a trip to the locksmith, you might measure the distance from the top of the cylinder to

the bottom of the keyhole before you take the barrel out of the door. Then measure from the bottom of the key to the bottom of each notch, subtract each figure from the cylinder dimension, and add a small fraction for safety. This will allow you to select a small assortment that will not have to be filed down much to be the proper length for the notches in your key.

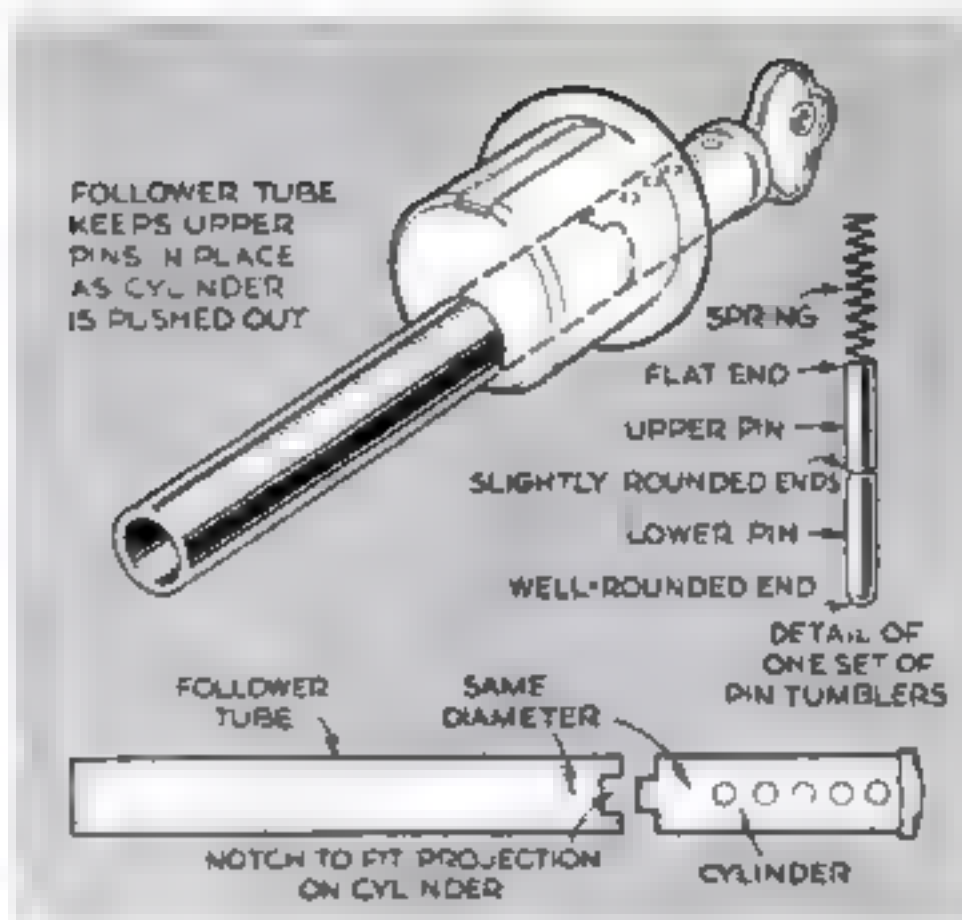
Remove short pins with the aid of tweezers (Fig. 3) after lifting them with the key. Replace with new ones; then, with all the pins either flush or above the surface, put the cylinder in the vise, key in place, and file across them (Fig. 4) until they are perfectly level. The pins are then dropped out on the bench in their relative position. Some cylinders have a steel ball at the bottom of each hole for an easy rolling action when the key is being inserted or withdrawn. With these, it is a good idea not to remove the balls from the holes. If you decide to do without the balls, longer pins can be substituted for the old ones.

When the pins have been removed, take a small twist drill or countersink in the fingers, as in Fig. 5, and slightly countersink the edge of each hole. The top ends of the pins must also be slightly rounded to remove the burrs. They can be held in a pin vise or even the chuck of a drill (Fig. 6). Reassemble the pins in the cylinder with the original well-rounded ends down next to the key.

Apply a coat of graphite all over the cylinder and pins and, by reversing the operation in removing it, slide the barrel back on the cylinder, but be sure they are turned slightly out of line so the two sets of pins will not slide over each other and possibly



7 When upper pins and springs are taken out of the barrel, they are returned one at a time starting from the back hole



catch or stick. Attach the rear cam and try the key a few times to be sure it works smoothly.

When putting the barrel back in the door, have the cam in its locked vertical position and screw the barrel tight against the spacer collar at the back. The cam must engage a lever or arm in the lock case, and care is necessary to get it to line up correctly with this piece. Occasionally the original position of the barrel may be found not to be the best. If so, a collar of a different thickness or an adjustable spring collar can be obtained. If the lock still fails to work smoothly, take the barrel out again and run a little lubricating oil into the main lock mechanism.

Upper springs rarely cause trouble, but if one should break or become damaged, it is not too difficult to take it out for replacement. Some barrels have a top cover or slide that can be tapped off with a small tool and a hammer to expose the pins. Where this slide is not provided, there is nothing to do but dump out all the pins and springs through the main hole after removing the cylinder.

The length of the upper pins is not as critical as that of those in the cylinder, but it is general practice to match up long and short pins so that a long pin in the cylinder, for instance, is under a short one in the upper part of the barrel. If two long ones were put together, there might not be room for them to be pressed up into the hole when an attempt is made to insert the key.

In replacing upper pins, the smooth, slightly rounded ends should be faced downward for contact with the cylinder pins. Often the top ends have a slight projection

at the center that fits into the end of the spring, but this is not always the case.

To reassemble upper pins that have been dumped out through the main hole in the barrel, use tweezers, as in Fig. 7, and insert the back spring and pin first, pushing the short length of brass tubing in to hold them in place after they have been pressed in with the tweezers. After each hole is fitted, the tubing is advanced until the barrel is again mounted on it. The barrel can then be assembled on the cylinder by sliding it on in the vise.

Remove the main mortise lock after the barrel has been taken out if it should need attention. In some cases a small hand knob on the inside of the door must be removed along with the spindle and main hand knobs or thumb latches. After cleaning, oil should be applied to the working parts, and weak or broken springs should be replaced.

Latches or dead locks of the surface type called rim locks are also a form of cylinder lock. Removing the wood screws and taking off the lock case will expose a small metal plate through which pass two long machine screws that hold the barrel in place. When these screws are removed, the cylinder and barrel can be serviced in the same way as those of the locks just described. A long blade will be found at the back of the barrel instead of a cam, but its removal is usually easy after a moment's study.

To complete the servicing job, the face of the barrel, if it is brass, bronze, or a similar metal, may be refinished to remove corrosion. Use a fine scratch wheel for a dull or satin finish, or a cloth polishing wheel with stick rouge for a high polish. Either method makes an old lock look new.

Oscillators—Tuning Forks

HOW TUBES GENERATE HIGH-FREQUENCY CURRENTS THAT

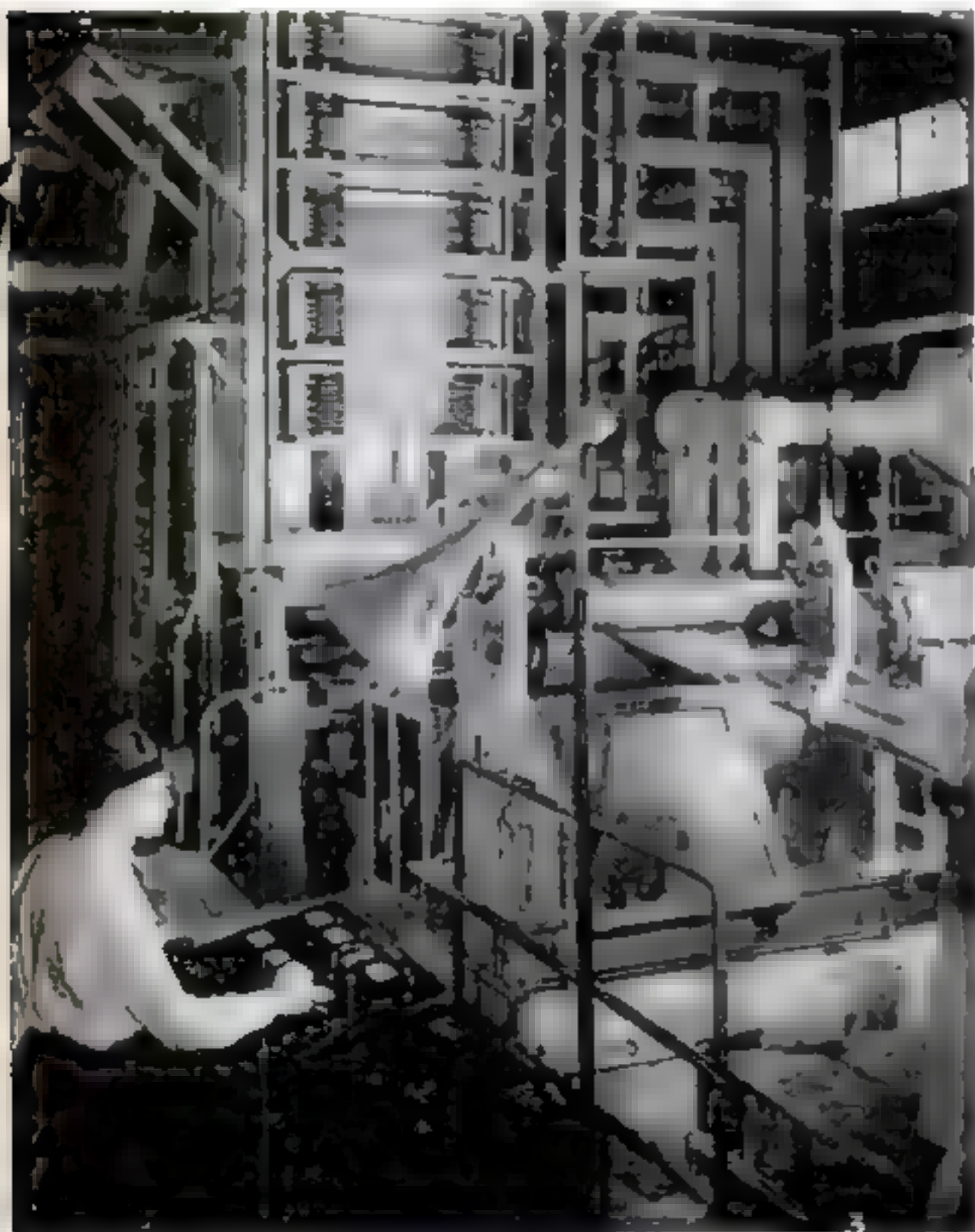
ALMOST everyone knows how the electricity of dry cells and household power lines behaves. But the same electrons comprising these currents can, under different circumstances, move in baffling ways. They will be transmitted through insulators and will be insulated by metal wrappings. They will follow a fairly direct path, but if the conductor loops or winds about, they will balk, die out, or escape and wander off through space. A hollow tube will prove a better conductor than a solid rod, for the electrons won't go through metal at all, but instead will race across the surface.

The current that acts so strangely is high-frequency A.C., a form of electricity that only electron tubes can generate and handle efficiently. Our familiar 60-cycle household current obeys much the same laws as does D.C. At 6,000 and even 60,000 cycles, A.C. is still reasonably akin to D.C. But at 600,-

000 cycles it begins to behave peculiarly in conductors.

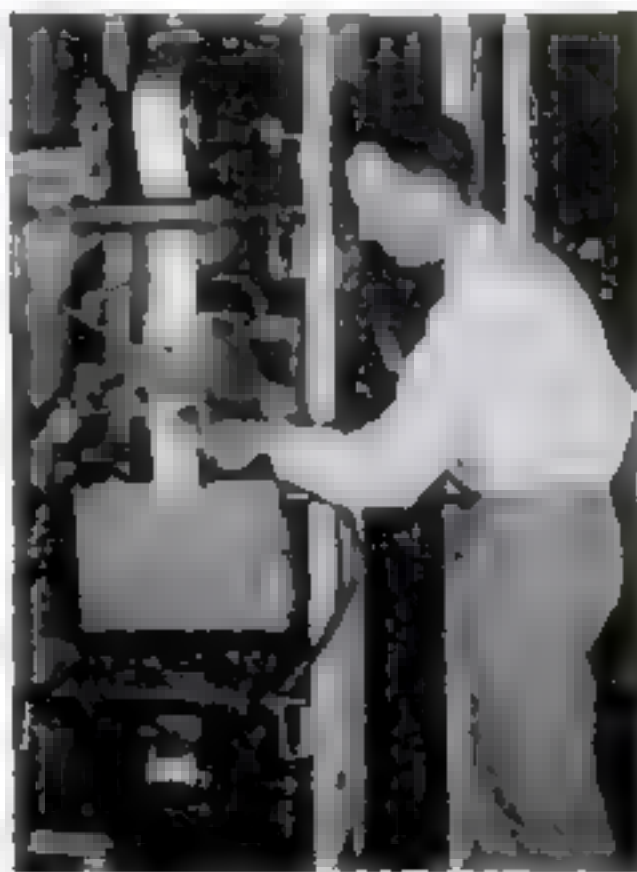
For example, a plain copper wire will conduct it more efficiently than the same wire with a thin plating of tin, even though the tin plating increases the cross section of the conductor. The reason? The electrons constituting the current, like all moving electrons, set up magnetic fields in and around the wire. At 600,000 cycles the oscillations are so rapid and the fields therefore so strong that they force the electrons apart, toward the outside surface of the conductor. If this surface is tin, a poorer conductor than copper, the resistance will be greater than that of an unplated wire.

At 50,000,000 cycles, or 50 megacycles, two loops in a conductor become an inductance. So does an ordinary paper condenser made of strips of tin foil and paper rolled into a spiral. The inductance effect is so



Radio-frequency induction heaters now permit a saving of two thirds of the virgin tin until recently needed for the production of tin plate. Note in the installation at the left, which is in a Republic Steel Corp. plant, the change in reflectivity when the tin fuses in passing the last of the coils

In the model tin-fusing mill that is pictured below, a Westinghouse engineer reads the temperature of the plated steel strip as it runs past the inductance. A water tank cools off the heated, tin-coated strip before it is wound up again



of Electronics

By
JOHN W. CAMPBELL, JR.

SPAN SPACE, HEAT WITHOUT FLAME, AND SMASH ATOMS

great that the condenser acts as a choke coil—a high inductive resistance.

Nor will an ordinary dielectric like paper do for condensers used at these frequencies. When a condenser is charged, an electrostatic stress is applied to the molecules of the dielectric between the plates. These molecules are thus "stretched" out of their normal position, and so store potential energy which is released when the condenser is discharged. But when the condenser is charged and discharged 50,000,000 times a second, the molecules cannot respond quickly enough. The electrostatic energy, instead of being stored and released, is expended in trying to move these sluggish molecules and is dissipated in the dielectric as heat. This renders wood, glass, rubber, waxes, and oils unsuitable for use as dielectrics in high-frequency work. Mica serves fairly well. Special plastics and ceramics are also used.

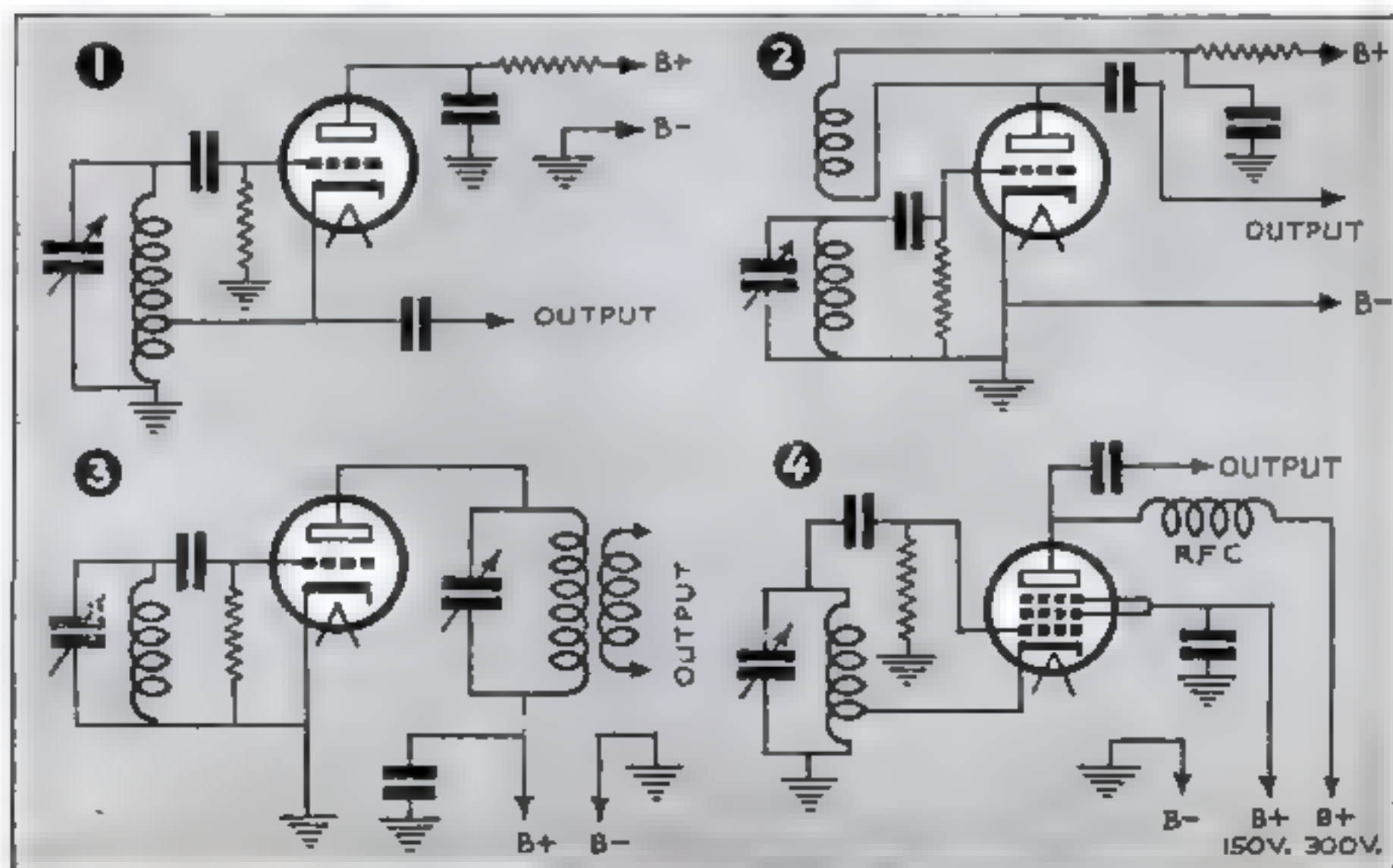
For the same reason that dielectrics must be carefully chosen, any nonconductor in the vicinity of a radio-frequency (R.F.) circuit will absorb some of the energy and so affect the electric characteristics. Conductors do the same thing, but for another reason. The field of energy surrounding a R.F. inductance will induce currents in any metal near by. Because these circle about within the metal itself, they are termed eddy currents. The R.F. energy that is absorbed and generates these is again manifested as heat.

Since both conductors and nonconductors cause adverse effects, no ordinary dynamo, with its iron cores, wire coils, and insulation, can generate high-frequency current efficiently, and this becomes a function of the electron tube.

In building an amplifier, we must guard against stray feed-backs—currents from the plate circuit that by inductive or capacitive effects are fed back into the grid of a preceding tube. Any feed-back is amplified, and the amplified fraction of it that is again fed back is further amplified, and so on, until the amplifier tube goes into oscillation, generating A.C. of a frequency that depends upon the values of the inductance and capacitance in the circuit.

Undesirable as this is in amplifiers, it enables a tube to function as an oscillator, or generator of high-frequency currents. An oscillator usually includes a condenser, a coil, and an amplifying tube so connected that some considerable portion of the output power is fed back to the grid. This feed-back energy must always be more than the loss in the grid circuit.

Many of the largest broadcasting transmitters and R.F. induction furnaces are controlled by the oscillations of a small tube such as a 6SK7 or 6J5. Frequently a 6L6 is used as the first power amplifier, followed by larger tubes, the last of which may be a bank of huge, water-cooled, 100,000-watt tri-



odes. But whether the final output is to power a cyclotron "atom smasher" or a precision electric clock, the oscillator circuit is essentially the same.

In some oscillators, such as those used in broadcasting and in frequency standards, the output frequency must be mathematically exact, but one intended for an R.F. induction furnace must deliver a heavy output current, and the frequency is of little importance. An audio-frequency oscillator designed for testing A.F. amplifiers must be capable of generating pure single-frequency tones up to 15,000 cycles per second. When tuned to 1,000 cycles, it must generate only that frequency, and not the second, third, or fourth harmonics at 2,000, 3,000, or 4,000 cycles.

Superheterodyne receivers, by means of a mixer tube, impress the incoming signal on one generated by an oscillator in the set itself, and the resultant "beat signal" is then amplified. This calls for an oscillator that will generate a reasonable amount of power, that can be tuned to any of a wide range of frequencies, and that will remain at any frequency it is tuned to.

A common oscillator is the Hartley circuit, shown in Fig. 1. The feed-back energy is obtained by inductive coupling in the coil, through the lower part of which the cathode current, and therefore the plate current, flows. The coil acts as an autotransformer,

and part of the energy appears in the upper portion of it, which is connected to the grid. Another standard oscillator is the tickler circuit (Fig. 2). Here the transformer effect between the tickler coil and the grid coil supplies the feed-back.

In the tuned-plate, tuned-grid circuit (Fig. 3) there is no apparent way for feed-back to reach the grid, but feed-back results, nevertheless, from the capacitance effect between the plate and the grid. This factor is always present in any vacuum-tube circuit, and is often alone sufficient to cause unwanted oscillation in high-gain amplifiers. Triodes oscillate readily in this circuit.

An oscillator with extremely good stability, and one that is not detuned by a change in the load on the output circuit, is the electron-coupled circuit shown in Fig. 4. The oscillator is the triode formed by the cathode, control grid, and screen grid, the latter acting as the plate. The plate proper merely collects spurts of electrons passing through the screen and suppressor grids, and therefore shows an oscillating voltage. The radio-frequency choke (R.F.C.) permits application of a positive potential to the plate, but blocks the return of R.F. current. A 6SK7 is excellent for this circuit.

Precision oscillators invariably depend upon quartz crystals. These are, in effect, supersonic tuning forks; they vibrate mechanically at a frequency determined by

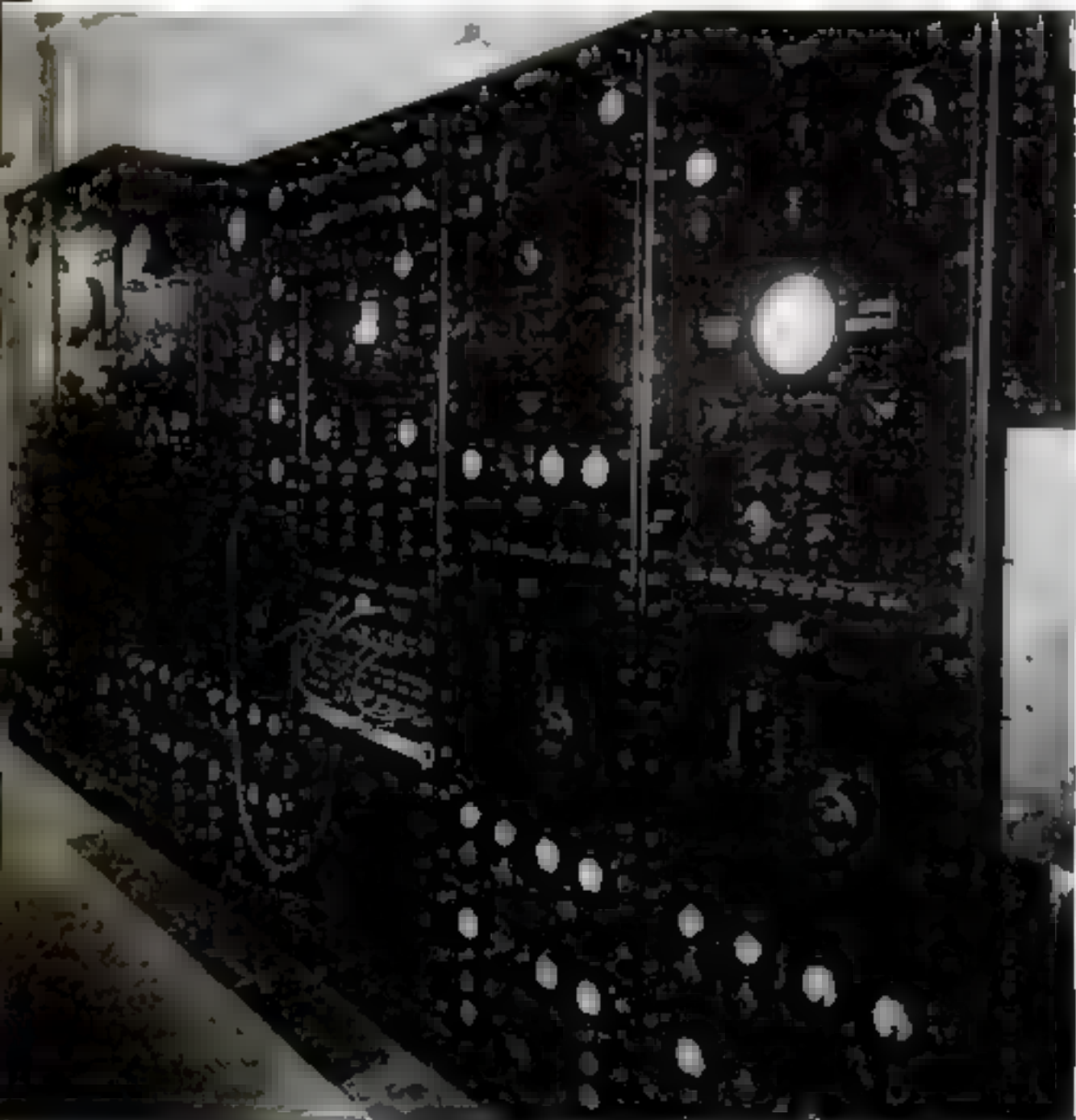


Photo courtesy of General Radio Company

Signals from station WWV are generated by such apparatus as this. Their frequency is counted by a synchronous electric clock that keeps step with every cycle and is regularly checked against time signals from the Naval Observatory

The crystal that controls the initial oscillation is in the insulated compartment below. Its temperature is kept within close limits by thermostats



their thickness and other physical characteristics. Put between metal plates, such a crystal changes shape to a microscopic degree when an electric charge is applied to the plates. Conversely, if it is set vibrating, it will itself generate an oscillating potential on its two surfaces. If an applied potential is of the crystal's own frequency, the entire system oscillates in harmony, but if the applied oscillation is out of step, it meets the counter potential generated by the crystal itself, and oscillation ceases. So the crystal oscillator circuit (Fig. 5) can generate only a signal of the frequency of the crystal.

The U. S. Bureau of Standards maintains radio station WWV, from which only signals of certain standard frequencies emanate at definite time intervals. Their accuracy of about one part in ten million is made possible by the multivibrator oscillator (Fig. 6). Its frequency is governed by the time required for a charge to drain off a condenser through a resistance. This interval may be from a billionth of a second to a minute.

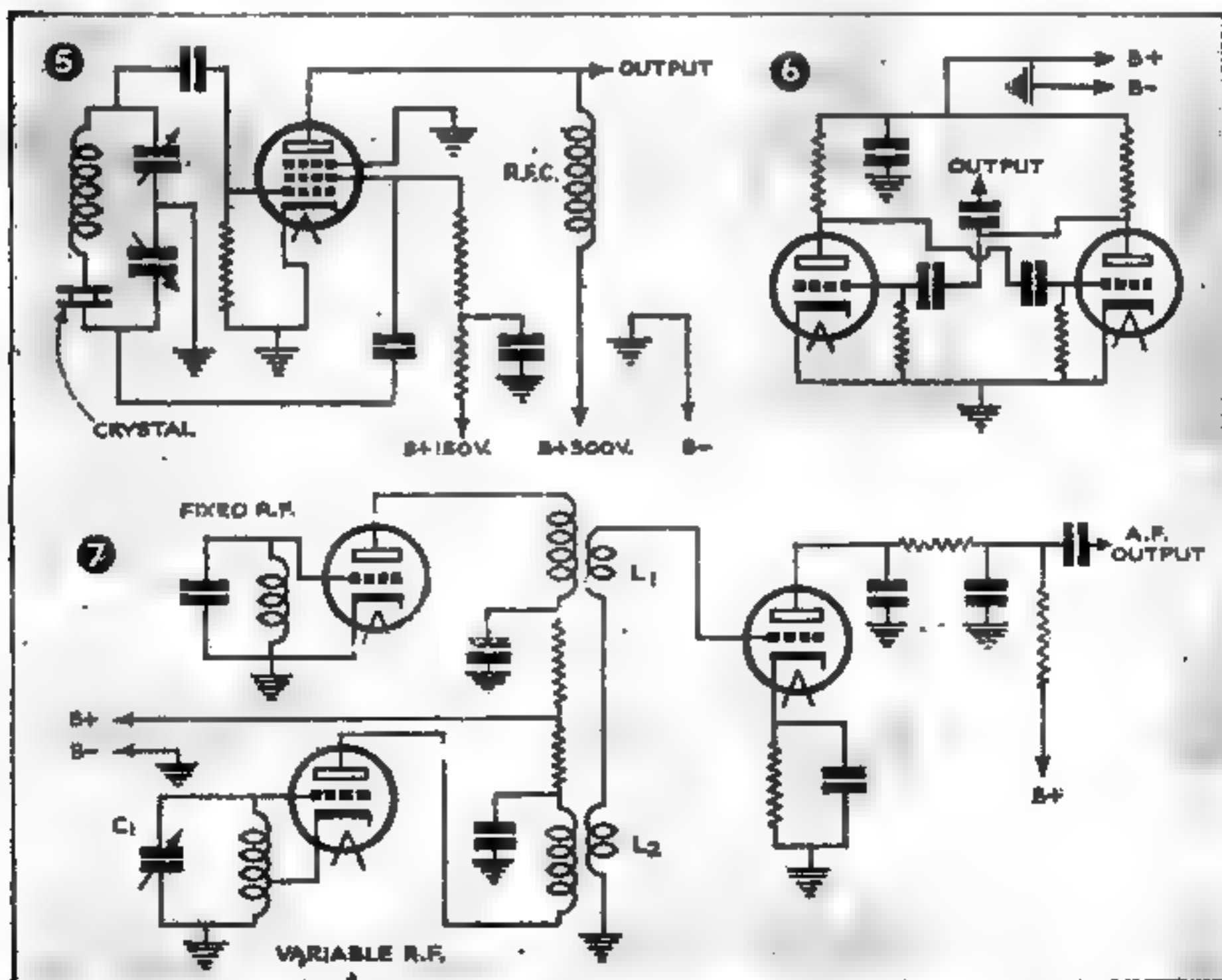
Unlike the other oscillators shown, this one readily generates the harmonics, or multiples, of any frequency to which it is tuned, and it easily falls into step with any outside frequency near its own that is fed into it. A precision crystal-controlled oscillator generates the original signal at 1,000,000 cycles per second. By means of multivibrator units meshed with it, this signal is

stepped up to as much as 15,000,000 c.p.s. and down to an audio frequency of 440 c.p.s.

One multivibrator unit locked in with the other produces a 1,000-cycle note, which is amplified to drive a synchronous electric clock. This clock is compared daily with time signals from the Arlington Naval Observatory, and by its dial the engineers of WWV can accurately count the number of cycles of any signal they transmit.

Figure 7 shows a beat-frequency oscillator commonly used to generate audio frequencies. To generate low frequencies with an ordinary oscillator would require big, clumsy inductances and condensers. This circuit can be tuned over the whole range of audio frequencies by the tuning condenser C.

There are two circuits, one tuned to a fixed frequency of, say, 100,000 cycles, which signal is fed into coil L_1 . The other can be tuned by C, to from 100,000 to 120,000 cycles. If it is tuned at 100,030 cycles, this signal fed into coil L_2 will be out of phase with that in L_1 most of the time, but 30 times a second the two will be in phase and reinforce one another. This beat frequency, fed to the mixer tube, will produce a 30-cycle note in the output. The same principle applied to radio frequencies makes possible the superheterodyne receiver, the beat frequency (in this case called the intermediate frequency) usually being 456 kilocycles.

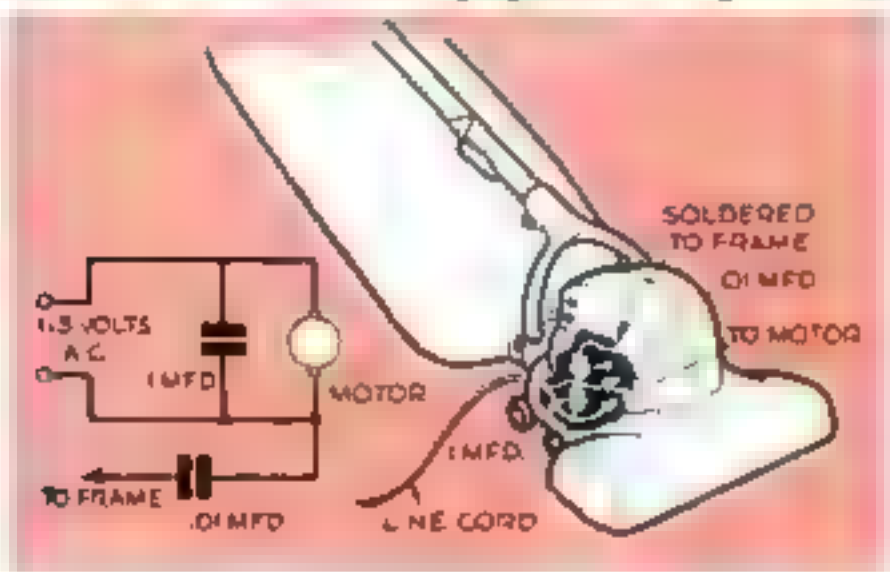


HOW TO STOP APPLIANCE STATIC

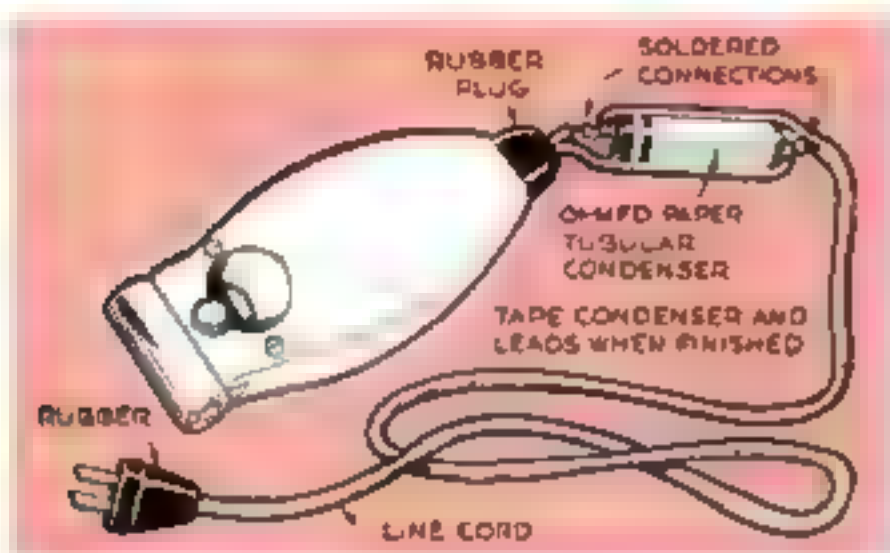
Servicing Your Radio

FEW people realize how much of the static heard on a radio receiver may come from electric appliances in the home. Especially noisy are the older types of appliances, for much of the later equipment is provided

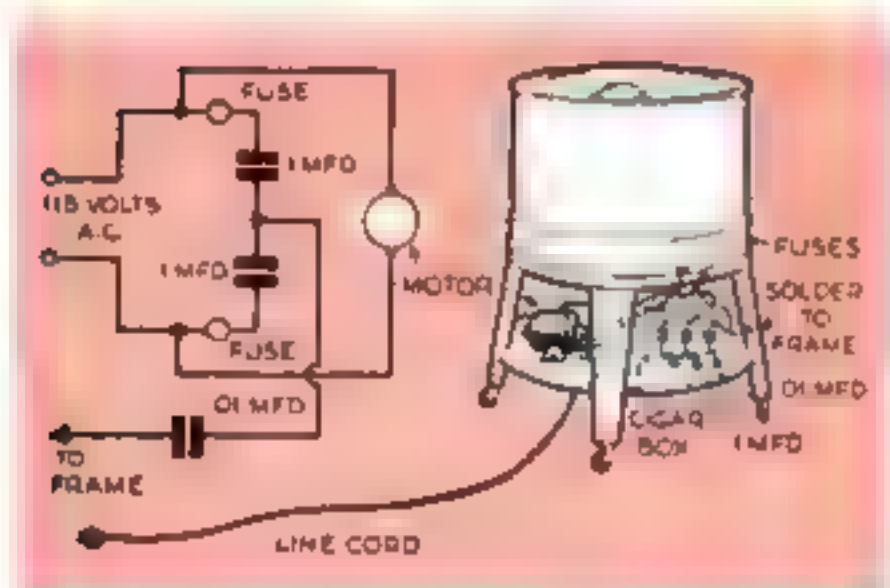
with some sort of built-in filter. Simple remedies can be effected by the amateur serviceman. Those described below call for noise filters put into the appliance circuit itself and will prove highly efficient.



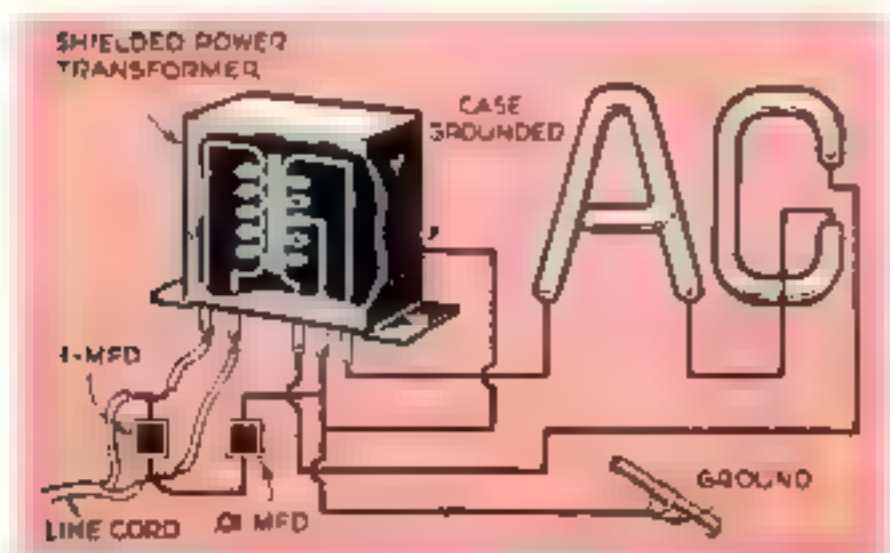
VACUUM CLEANER. Two paper tubular condensers are required. Each is rated at 400 volts, but one should have a capacity of .1 mfd. and the other of .01 mfd. It is important to have these values correct both for this and other filters. The .1-mfd. condenser is connected across the motor, while the other is connected from one side of the line cord to the metal frame of the vacuum cleaner. Sometimes static caused by the machine can be reduced still further by reversing the plug in the wall socket.



ELECTRIC RAZOR. This is a noisy troublemaker that will interfere with reception out of all proportion to the size of its tiny motor. It is, however, the simplest of the appliances to filter. Connect a 400-volt, .01-mfd. paper tubular condenser across the cord at a point near the A.C. motor plug, soldering one lead of the condenser to one wire and the other lead to the other wire, as shown in the drawing at the left. Both the condenser and the exposed wire can be covered with rubber tape. So secured, the filter will not be in the way during use.



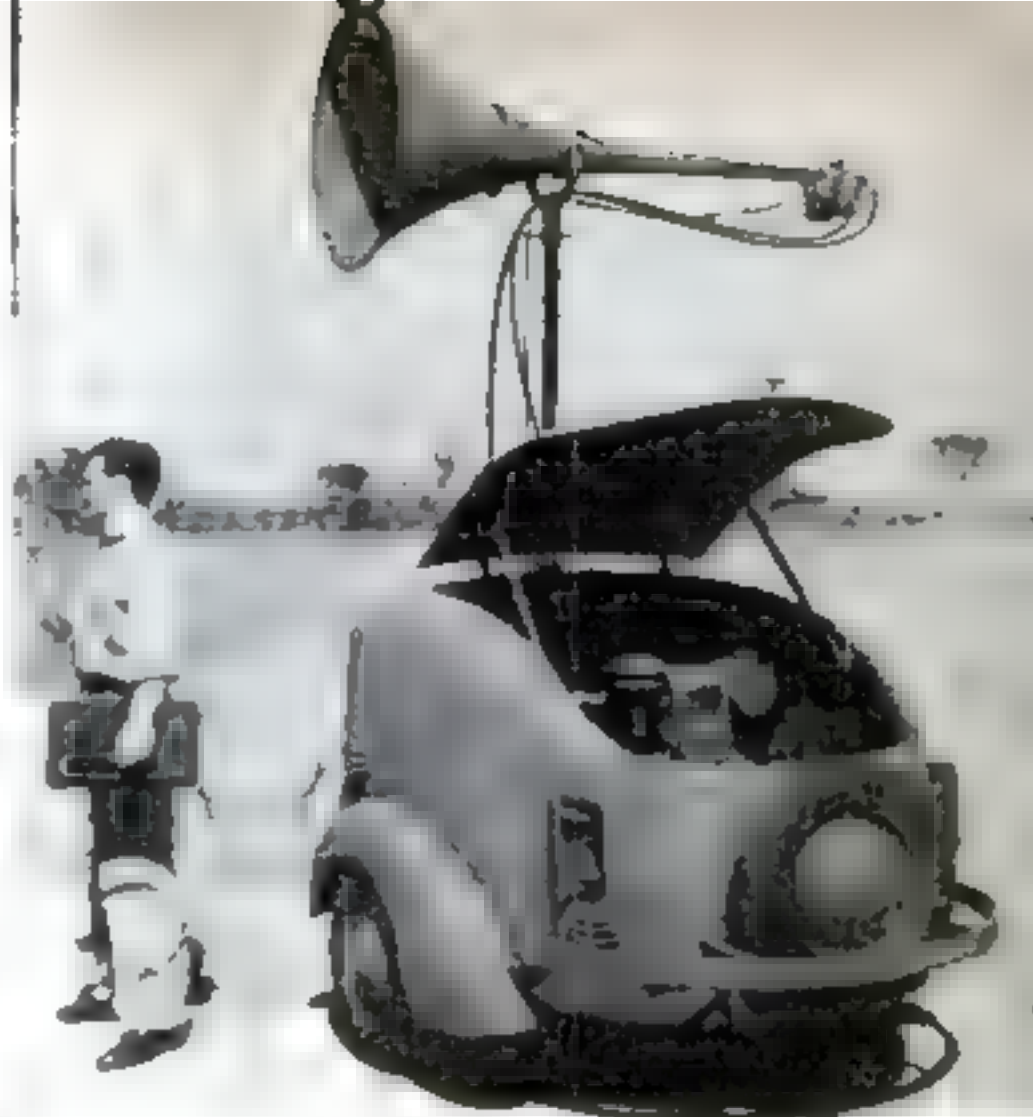
WASHING MACHINE. Two 1-mfd. condensers, one .01-mfd. condenser, and two 10-amp. fuses will filter a washing-machine or home workshop motor. Connect the fuses with the two 1-mfd. condensers across the input of the motor as in the diagram. Then connect one lead of the small condenser to a wire put in the circuit between the 1-mfd. condensers and ground the other lead to the metal frame of the machine. The fuses guard against a short circuit. This whole setup can be mounted in a wooden box near the motor.



NEON SIGN. Store owners and apartment dwellers in buildings having stores on the street floor are often troubled with static caused by neon signs. The owner of the sign can keep most of this static from entering the electric lines by inserting two paper condensers in the A.C. transformer circuit, as shown in the diagram. A 1-mfd. condenser is connected across the transformer, and a .01-mfd. condenser is connected between one side of the primary and the metal casing of the transformer, which is connected to ground.

radio ideas

SOUND PROJECTION has been so developed that, in tests of one new mobile unit, readings of 88 decibels have been recorded at 3,200'. Other tests have shown it to be efficient within a range of from one to 18 miles. This amplifier is mounted on a two-wheeled trailer that can be attached to any kind of car, or pulled by hand, for use at any spot it is needed. Built into the trailer is a self-contained plant making it independent of outside power sources. Used with either a single horn or multiple horns, the unit is capable of broadcasting alarm signals, voice, or music within a range of from 100 to nearly 4,000 cycles.

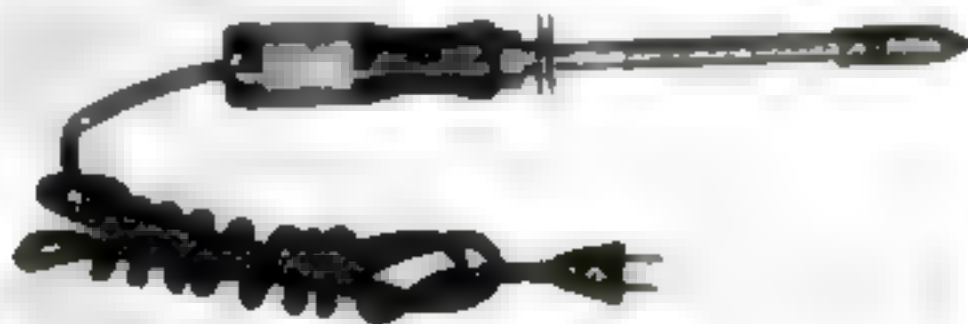


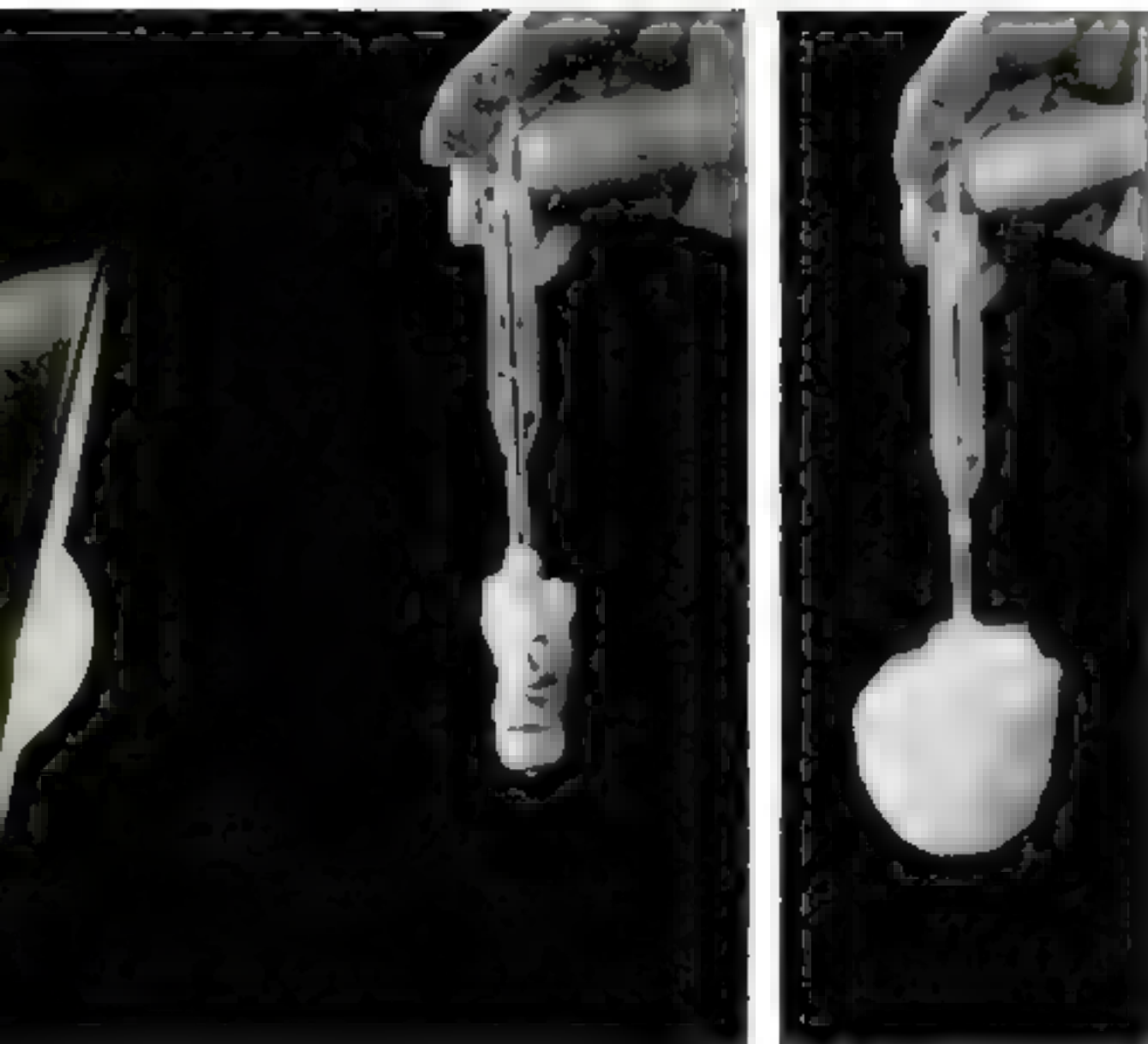
PHONOGRAPH-RECORD INDEXING can become a pleasant occupation with the new record "log" shown at the left, and it can prove a great convenience in quick reference to album and page number, particularly so to the music enthusiast who counts his records in scores. The index file is so arranged that records can be listed by titles on alphabetical tabs that can be readily seen without thumbing through a number of pages. A leatherette binding gives the ingenious filing system a neat appearance.



A LIP MICROPHONE that eliminates background noise has been invented for the Army and has many possibilities for peacetime use. The mike has two holes—one against the lips through which the voice enters to strike one side of the diaphragm, and the other on the opposite side. Outside noises, being farther away, enter both holes with equal force, strike the diaphragm from both sides, and neutralize themselves.

SOLDER HELD IN THE IRON frees one hand for supporting or adjusting parts when an electric soldering iron like that shown below is used. A well in the tip is filled before the job is begun, and the solder runs down through a groove.





AIR CONDUCTS HEAT POORLY when enclosed in "dead space" so that the heat can't be transmitted by convection. You can demonstrate this by fluffing a small ball of cotton lightly around the bulb of a thermometer, as at the right above, and holding

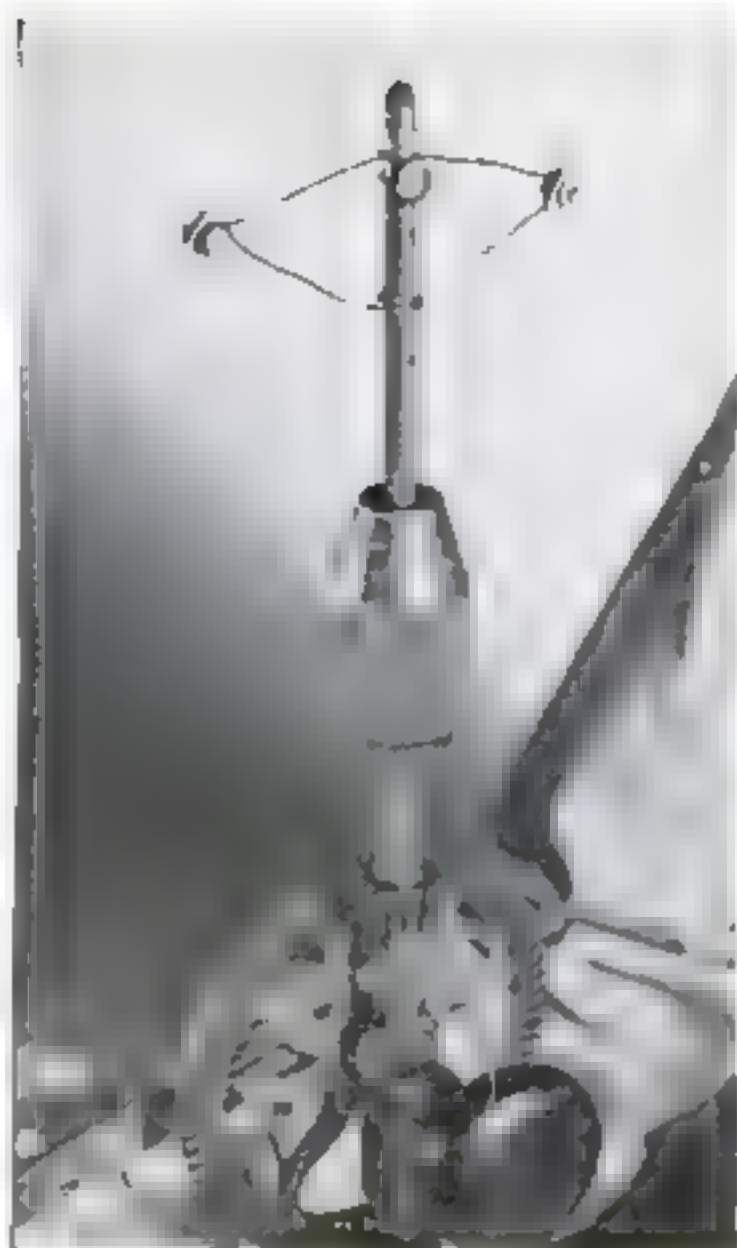
it a certain distance from a lamp for a definite length of time. Note the rise in temperature; then squeeze the same wad of cotton tightly around the bulb, as shown in the left-hand photo, and repeat the test exactly as before. The mercury will rise much higher in the second experiment, showing that the compressed cotton conducts heat to a far greater degree. The explanation is that "dead air" trapped between the fibers of the fluffed cotton—and not the cotton itself—gives the substance its chief heat-insulating properties. Thus, wool is warmer than cotton because its fiber structure is such that it can trap more dead air. This principle is followed in the manufacture of insulating materials for

houses. Regardless of the form of the material used—wool, pellets, batts, or rigid boards—it is so made that there will be a maximum of dead-air space to hinder the loss of heat. Rigid boards of this type are usually of cellular structure.

LAWS OF ACCELERATION affect bodies rolling down an incline as much as they do freely falling objects. This principle can be demonstrated with a marble and a short cardboard trough raised just enough at one end so that the marble will roll easily. By releasing the marble at the upper end of the trough and timing its travel by the ticks of a clock, you will discover that it takes the marble half as long to cover the first quarter of the incline as it takes it to roll the remaining three quarters. The same acceleration will be evidenced on a longer trough, the marble rolling nine times as far in three seconds as it did in one, and 16 times as far in four seconds. Acceleration, due to gravity, causes it to roll in any given time a distance that is directly proportional to the square of the time. A similar

formula will hold if the marble is allowed to fall freely, the distance being calculated by multiplying the square of the time of descent in seconds by 16 feet, the distance a free-falling body travels in the first second. The formula is: space equals half the acceleration of gravity times time squared.

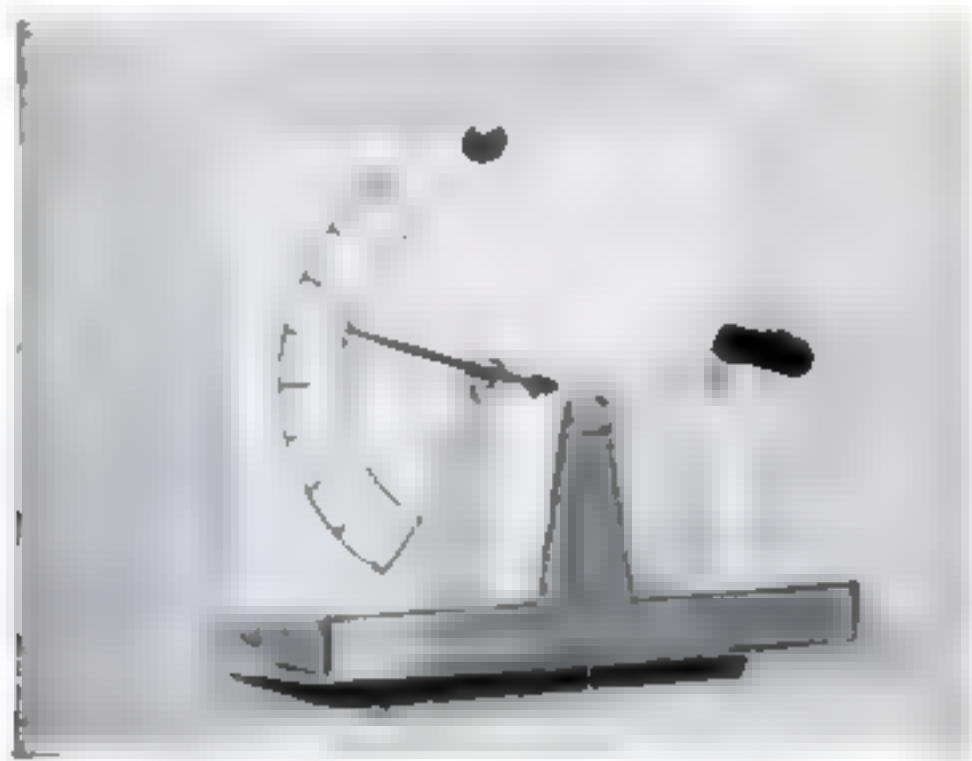




CENTRIFUGAL FORCE is applied to steam-engine and phonograph-motor governors in a manner that can be simulated with a hand drill, some wire, two short bolts, and a hexagonal pencil arranged as shown above. The six-sided pencil will keep the wires from slipping as the assembly is whirled in the drill, yet allow the lower loop of wire to slide up and down, while a thumbtack holds the upper loop in position. The faster you spin the drill, the higher the bolts will rise. Suitably applied, this force closes a steam feed valve, or applies friction to a phonograph motor, to keep the speed constant.



A TUG OF WAR between two balls mounted on a shaft, which in turn is mounted in a wooden frame that can be rotated as shown in the photo, involves a centrifugal principle that illustrates the mutual rotation of the earth and the moon—a matter of mass times velocity. Use either clay or wooden balls tied together with a short cord, and note how either the large ball or the little one will pull the other in its direction, depending upon how far each is from the axis of the frame when the frame is rotated. At one off-center spot the two balls will exert the same pull, both having the same momentum though their size and speed are different.



ATMOSPHERIC HUMIDITY can be measured on a hygrometer actuated by a human hair that reacts to the dryness or dampness of the air. One end of the hair, which should be about 4" long and washed in cleaning fluid, is attached to a fixed point. The other end is wound around and fastened with sealing wax to a large-eyed needle mounted between two standards, as in the photo. The holes of shirt buttons act as bearings on which the needle turns like a shaft. A pointer, secured through the eye of the needle, will rise in dry weather as the hair shrinks and twists the shaft. On a damp day, the hair will stretch, letting the pointer fall.

IRON

**Generously Supplied by Nature,
This Vital Element and Its
Compounds Play a Tremendous
Role in Man's Everyday Life**

By LOUIS TEICHMAN

IRON, in its pure, solid state, is rarely found in nature. Its occurrence in meteors indicates that—if the earth is not much different in chemical makeup from the rest of the universe—the center of the earth is composed largely of iron. It is from the earth's crust, however, that we must obtain the metal, usually in oxide form.

One way in which iron ore can be converted into iron can be demonstrated by this experiment: Spread about 1 oz. of powdered iron oxide along a heat-resisting tube about 12" long. (Hematite, jewelers' rouge, or Venetian red can be used.) Mount the tube on a stand and use a short glass tube and a one-holed stopper to connect one end of it to a supply of illuminating gas. Fit the other end with a stopper carrying a short tube drawn out to a point.

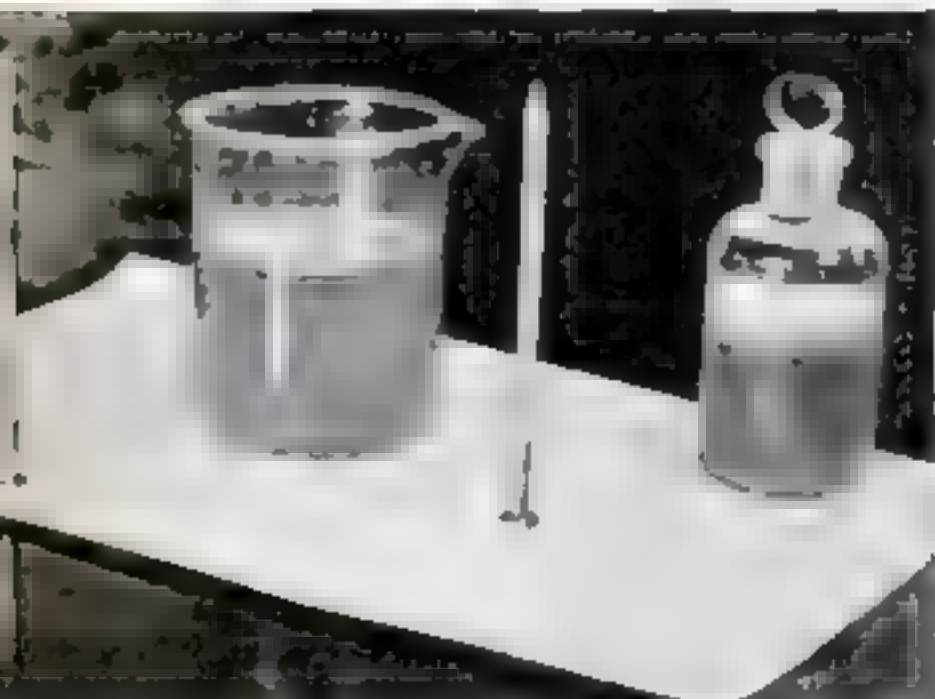
After running illuminating gas through the tube until all air is removed, light the gas issuing from the nozzle. Then strongly heat the section of the tube bearing the

ferric oxide. Water will be seen forming at one end of the tube. At the end of five minutes turn off the heating flame, but let the nozzle flame burn until the tube cools. If the contents of the tube are then tested with a magnet, you will find that they have resolved themselves into pure iron and water, the hydrogen in the gas having combined with oxygen to form H_2O .

A similar reaction takes place in the thermite incendiary bomb, but here the oxygen is removed from the ferric oxide by aluminum, generating very high temperatures. To try this experiment, make an intimate mixture of three parts of magnetic iron oxide to one part of aluminum powder, by weight. Place a small portion of this mixture in a flowerpot, covering the hole with a piece of paper. (A pail of dry sand beneath the pot will catch the molten metal that will be formed.) Prepare a primer by mixing some aluminum powder with powdered potassium chlorate. Caution: The latter is a tricky, hazardous chemical, sensitive to shock and capable of exploding if roughly ground with a metallic powder. Using great care, stir the ingredients together with a spoon, taking only teaspoon-sized quantities at a time. Place a layer of the primer over the thermite mixture and ignite it with a piece of magnesium ribbon, or by adding a few drops of concentrated sulphuric acid to a small mound of powdered potassium permanganate placed on top of the primer. Use caution for, once started, the reaction cannot be extinguished, and will take place even under water. The iron oxide supplies all the oxygen needed to support the reaction, which is independent of atmospheric oxygen as the oxygen of the Fe_2O_3 changes places, joining the aluminum and leaving the iron.

Affinity for oxygen, one characteristic of iron, invites rust. This is avoided by plating with a non rusting metal. The nail at right below has been so treated by immersion in copper sulphate

The action of a thermite incendiary bomb can be duplicated safely with the aid of the apparatus below. Drops of sulphuric acid on potassium permanganate create a fuse to ignite the mixture



The difficulty of separating oxygen from oxides of iron indicates that iron combines with oxygen easily. We know this to be so through our continuous fight against rusting. That iron will actually burn can be demonstrated by the following experiment: Place a small amount of potassium chlorate in the bottom of a test tube and heat it until the chemical melts and gives off bubbles of oxygen. Roll and fit some steel wool into the test tube, leaving enough wool hanging over the top to keep it from falling to the bottom of the tube, and adjust the wool to come within 1" of the potassium chlorate. Remove the wool, heat it in the flame of a burner, and quickly reinsert it in the tube. A brilliant reaction will take place, with small balls of molten iron oxide forming on the wool, due to the heat of combustion. The rusting of iron and the burning of iron represent similar chemical reactions, differing principally in speed.

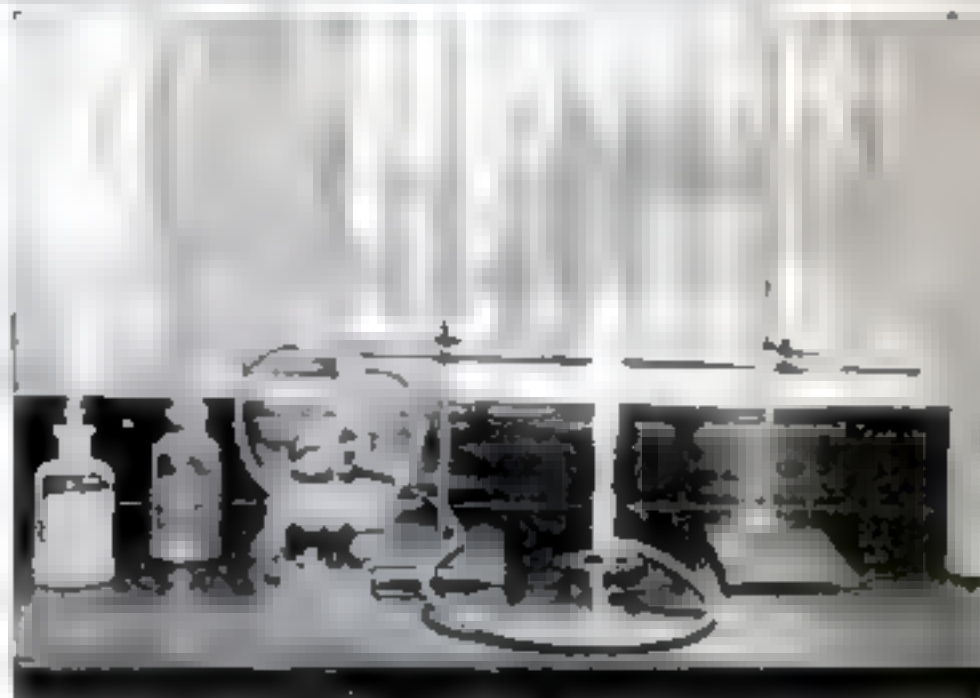
Repeat the experiment with sulphur instead of the potassium chlorate to show the formation of iron sulphide. Add hydrochloric acid to the iron sulphide and no-



Industrial iron is first cast into huge ingots like that shown above. This one, weighing 192,000 lb., was heated two weeks to bring it to a temperature of 2,200 deg. Photo courtesy Allis-Chalmers Mfg. Co.

Iron ore is reduced to iron in the setup below as illuminating gas is passed over the heated ore in the tube. Hydrogen in the gas combines with the oxides. Escaping gas is ignited for safety

Best results can be obtained with the same setup if pure hydrogen, drawn from a flask containing zinc and sulphuric acid, is used instead of gas. A similar process is employed to make sponge iron



tice the odor of hydrogen sulphide that results.

Iron and sulphur can be used to demonstrate the difference between a compound and a mixture. Mix thoroughly some iron filings and some sulphur powder. A magnet will prove that the iron still exists in the form of an element. Now place the mixture in a test tube, and heat. Once started, the reaction will spread with a glow throughout the tube, and continue without further heating until all of the iron has combined with the sulphur in the compound iron sulphide. No attraction will occur when the FeS is tested with a magnet.

Rust can be prevented by coating or plating iron with a metal that itself does not rust. One way is to clean some nails with an emery cloth and place them in a dilute solution of copper sulphate. The nails will become plated with a bright layer of copper.

The home experimenter can make blueprint paper by mixing equal volumes of a 10-percent solution of potassium ferricyanide and a 10-percent solution of ferric ammonium citrate. Brush the solution on paper and allow it to dry in the dark. To make a simple print, place a key or a photographic negative on a small piece of the prepared paper, and expose them to light. When the edges of the paper are seen to be sufficiently blue, wash off the chemicals in running water and allow the print to dry.

Many interesting experiments can be performed to show the two forms in which iron compounds exist. Clean some nails by placing them in hot, dilute hydrochloric acid. Rinse the nails in hot water and place them in fresh hot hydrochloric acid in a clean beaker. Heat for five minutes and then lower the flame to a point where the solution will just be kept hot. As long as the solution is hot and in contact with the nails, the iron compound will remain in the form of *ferrous* chloride. But if allowed to cool while exposed to air, the ferrous chloride will be oxidized to *ferric* chloride. The oxidation can be hastened by adding a few drops of hydrogen peroxide.

Add a few drops of ammonium hydroxide solution to some of the hot ferrous chloride in a test tube. The resultant white precipitate of ferrous hydroxide turns to brown ferric hydroxide when exposed to air, or when peroxide of hydrogen is added to it.



Blueprint paper can be made by brushing mixed solutions of ferricyanide of potassium and ferric ammonium citrate on a piece of ordinary paper

Now add a few drops of potassium ferricyanide solution to the hot ferrous chloride, and there will be formed a white precipitate that will turn blue when exposed to air, or when oxidized by hydrogen peroxide.

Repeat the same experiment with potassium ferricyanide. A dark blue precipitate will form at once.

If potassium thiocyanate is added to the ferrous chloride, no reaction takes place. On being oxidized, however, a blood-red color (ferric thiocyanate) is formed. This reaction distinguishes ferrous and ferric compounds from each other.

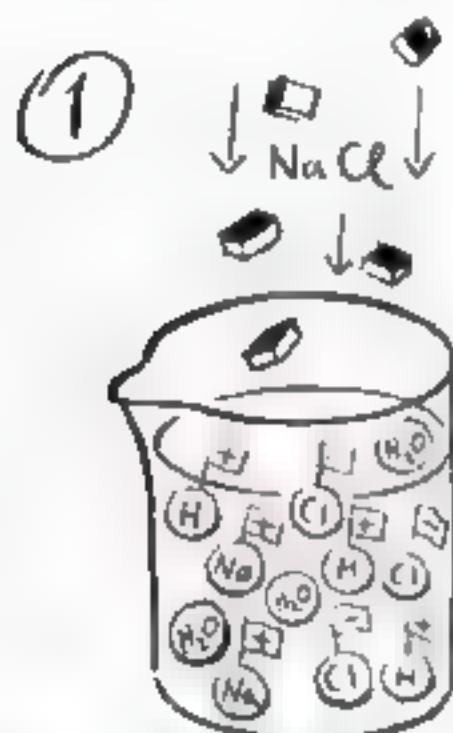
An iron ink can be made by adding a solution of tannic acid to the hot ferrous chloride. If the resulting solution is exposed to air, a permanent black color is obtained.

The structural uses of iron are so well known and taken for granted that few give thought to the other ways this metal exerts its influence upon modern economy, and even life itself. For example, vital oxygen is carried to every cell in the human body by hemoglobin—the iron compound in blood. Other iron compounds are essential to the dyeing of shoes and numerous articles of clothing. Camera lenses, and even the fillings of teeth, are polished with that simple iron compound called jewelers' rouge. Designs for iron structures are put on blueprints, also made with an iron compound, before they become a reality.

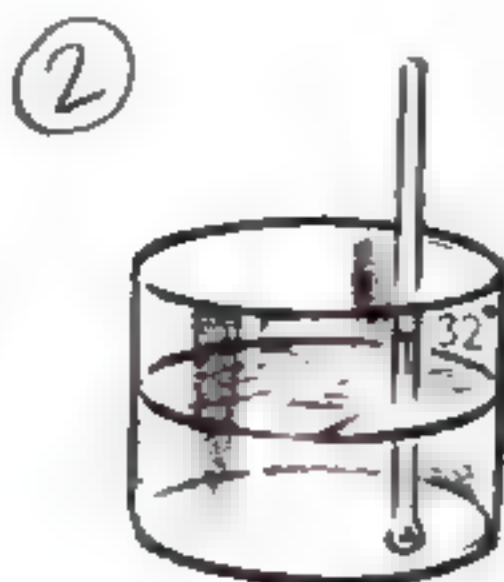
Great strength was added to iron, and a new field was opened for it by the invention of steel. Iron alone is a hard, tough metal, but its resistance to torsion and compression is vastly increased when the steelmaker includes small amounts of carbon in the manufacture of his finished product.

How much do you know about chemistry?
Try to select the correct answers to the

questions below, and then turn the page up-
side down to see how many you got right.



What is this phenomenon?
Is it dissolution, calibration,
regurgitation, or ionization?



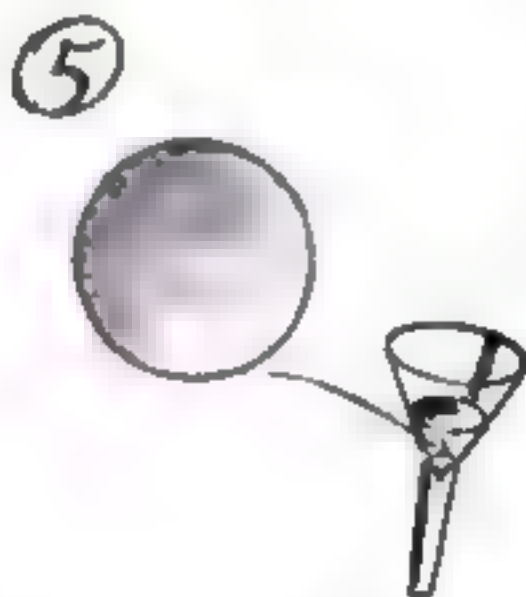
Before water freezes, must it
lose its heat of fusion, heat
of solution, or atomic weight?



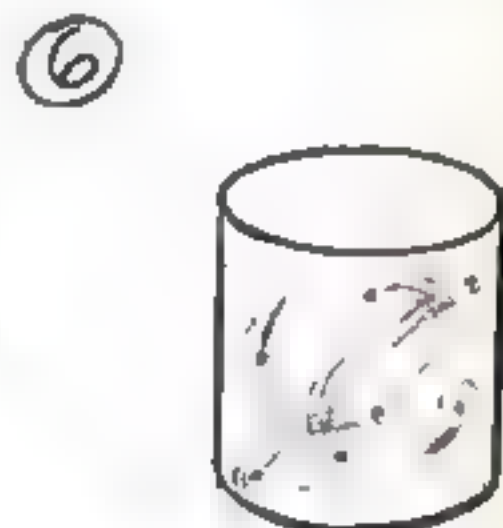
Does this figure symbolize the
periodic system, hydrocarbons,
the benzene ring, or a vitamin?



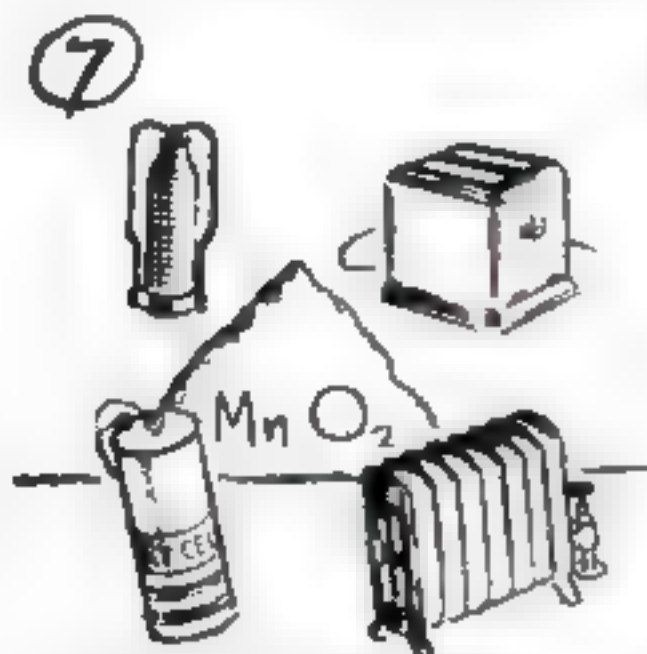
Unless at least one precipitate
or gas is formed, are reactions
complete, reversible, or smelly?



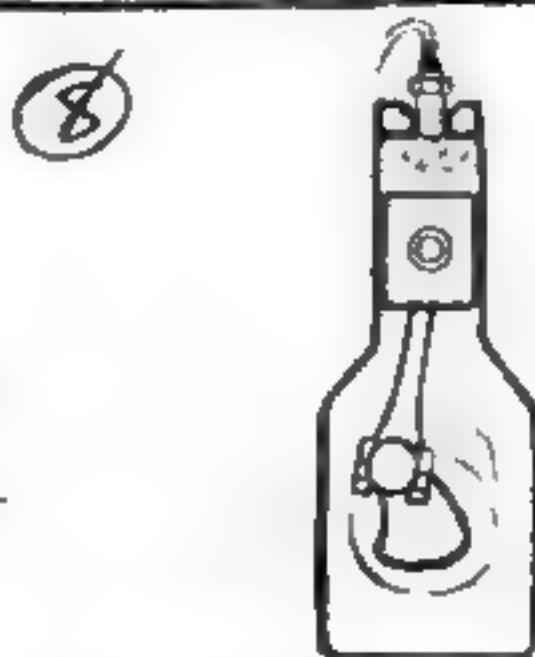
To make a cone, would you
stuff filter paper in a funnel,
twice fold it double, or cut it?



Made to move faster, molecules
become radioactive, fluoresce,
get hot, or turn into crystals?



Is manganese dioxide found
in an electric toaster, gas
mantle, dry cell, or radiator?



Do auto engines burn a mix-
ture of gasoline with ether,
steam, air, or vaporized oil?



When iron rusts, does it
get lighter, stay the same
weight, or grow heavier?

ANSWERS

7. Dry cell
8. Air
9. Grow heavier.

4. Reversible.
5. Twice fold it double.
6. Get hot.

1. Ionization.
2. Heat of fusion.
3. The benzene ring.

MOTORIZED Cultivator

WEEDS WHILE YOU WALK

By E. W. LEHMANN

Head of Department of Agricultural Engineering,
University of Illinois

PARTS from all sorts of machines went into the construction of this home-built garden cultivator that can be powered either by an electric motor or a small gasoline engine. Steered by hand like any standard push cultivator, the mechanized device will save much hard labor as it moves with a speed of about $1\frac{1}{2}$ m.p.h. through ordinary soils.

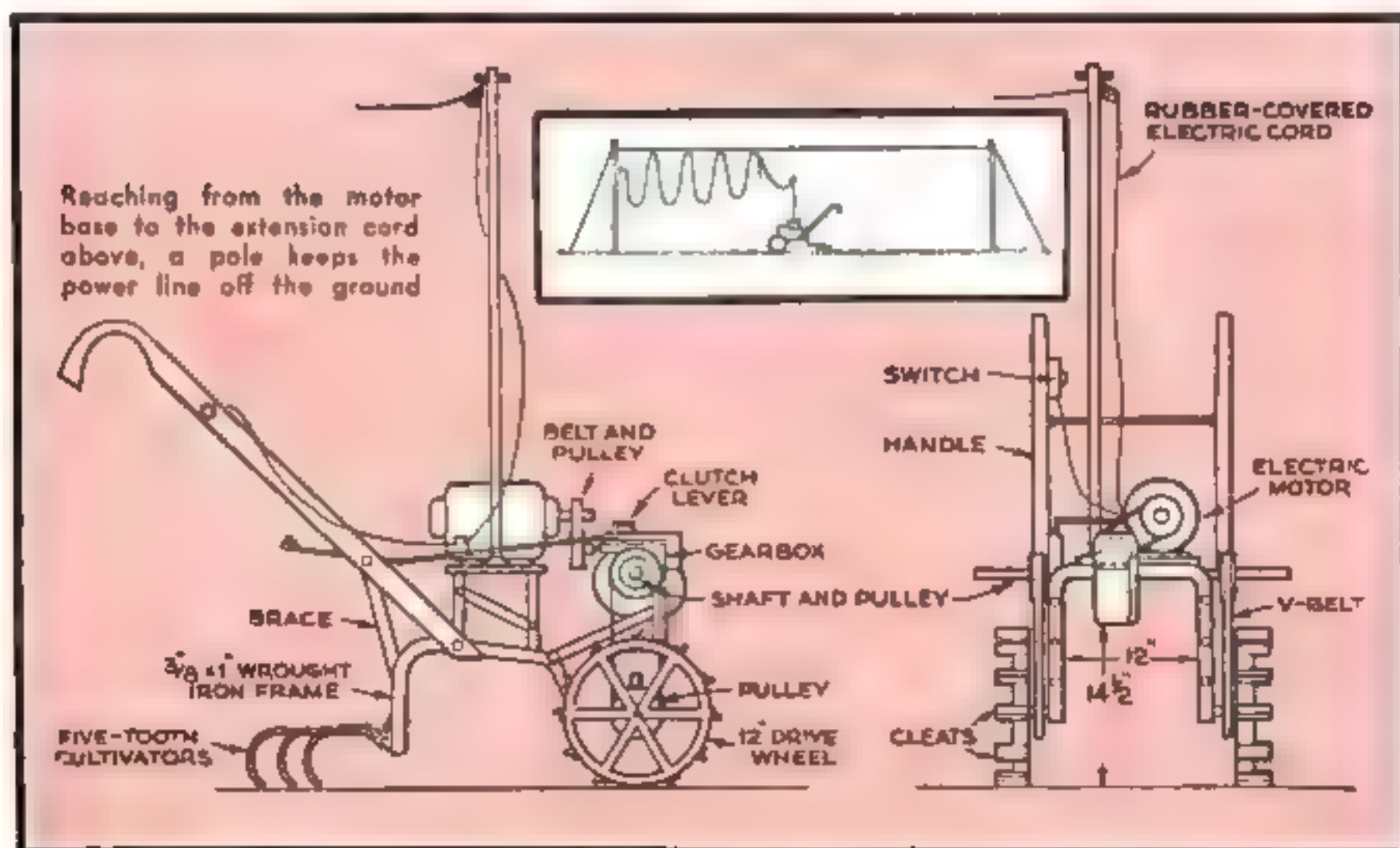
Two wheels for the machine were obtained from a junk yard, and the cleats were welded to them. Handles like those used on a horse-drawn cultivator were purchased new, but the cultivating units were salvaged from an old push-type implement. V-pulleys on the drive wheels were parts of worn-out auto pumps, while the gearbox was taken from a discarded washing machine.

The drive pulleys were welded to the wheels, and the axles were welded to slotted adjusting plates. The latter were bolted to

the frame, which was built up of 1" angle iron and $\frac{3}{16}$ " by 1" pieces of wrought iron bolted together. Both the electric motor and the gas engine shown in the photos were fitted with pulleys of the same size as that on the input shaft of the gear box. Likewise, the pulleys on the ends of the drive shaft extending through the gear box were the same size as those on the drive wheels. Total speed reduction (about 40 to 1 in this case) was thus secured through the gearbox. For gearboxes of other reductions, make compensating changes in the pulleys.



A small electric motor powers this cultivator assembled from odds and ends of scrap material



As a source of power, a gas engine has the advantage of making the cultivator usable anywhere. The one employed here was taken from the same washing machine that yielded the gearbox. It was a two-cylinder, $\frac{1}{2}$ hp. unit with a speed of 1,850 r.p.m. Because of its noise, however, such a power plant may prove objectionable in gardens surrounded by dwellings. On the other hand, no one will be disturbed by a silent electric motor, but such a unit cannot be used in a garden that is not convenient to a source of current.

Operation of the cultivator with the electric motor was made possible by providing a waterproof power outlet at one end of the garden. Between poles erected at each end of the plot, steel wire was used as a support for the long extension wire used to conduct electricity to the motor. The cord can be attached to the wire with harness snaps, shower-curtain hangers, or any similar device that will hold it aloft and yet permit its removal. Such an arrangement allows for cultivation back and forth across a garden with only a limited length of loose cord to handle. For safety, the motor housing should be well grounded to the frame of the machine, and the cord should be kept off the soil at all times. Motors of $\frac{1}{2}$ hp. are usually adequate unless the soil is heavy and easily compacted.

With either type of power plant, the cost of operating the cultivator is very slight, amounting to less than two cents an hour when the electric motor is used and only a little more with the gas engine. Common practice is to prepare a seedbed first by plowing and harrowing, and then—just before planting—to use the cultivator for further stirring of the top soil. Weed control and aeration of the soil become easy matters if the cultivator is used before the weeds appear.

Mounted on the same base that accommodated the electric motor, a gasoline engine makes the unit practical for gardens remote from current supply



Farm-Built Tractor Plow Equipped with Right and Left Shares

CONVERTED from a truck, this tractor carries an unusual plow arrangement manipulated by two levers, one of which can be seen in the driver's hand. Either of the two plowshares can be adjusted for depth, and raised or lowered separately from the driving seat. This feature enables a farmer

to plow the length of a field and return along the same plowed edge, using first one plow and then the other one. The picture below shows how the plows are tilted on an iron frame that revolves in an arc. Most of the plowing mechanism was welded together out of scrap pieces of iron.



Bombing Tokyo from a Silo

(Continued from page 58)

underneath. Now I saw the first navigation chart projected on the screen. As the hours dragged by to the steady drone of the engines, I watched the fuel "simulatedly" used up. With the help of my copilot, I adjusted the throttle for best economy; we had a long trip ahead. I set the turbos and the manometers, and tuned in the radio for a broadcast to pass the time. Later, I noted that the local radio for Orlando, Fla., was even made to fade. Then the operator tuned in on our first destination, Trinidad. The RDF needle became more and more sensitive as we approached South America. In seven hours, the coast of this continent, seemingly coming out of the blue-green Caribbean, slid under the ship on the screen. We had been averaging 300 miles an hour and, as Port of Spain went below, we even followed the "military corridor of approach," for this was actual training for war. After landing at Waller Field, we climbed down the ladder to the ground, to wait while the ship was reserviced. Coffee would taste mighty good now! After all, we'd really been in that cockpit nearly eight hours. Stepping off the ladder, we walked through the dim light to the open sunshine—the terrain looked just as green as I expected Trinidad to appear, but the pine trees looked too much like Florida. I saw a couple of Wacs and then a Coca-Cola truck and began to come out of my dreams.

As the days passed, I went on longer navigation flights and finally came to Africa. All along that trip I'd look at the dark heavens where the stars were "simulatedly" covered with an overcast. The trackless waste of darkness below could be the ocean or the black jungle. Every now and then, I'd hear a voice, "Okay, Joe, turn on the stars," and overhead would appear the friendly collimated lights. I saw our navigator's sextant light flash for a few seconds as he shot our position. I could see the Big Dipper almost on the horizon, and I knew we were near the equator. Then I'd prove it by finding the Southern Cross, and I'd call "Corona Australis" to my navigator to show him how smart I was. There would be Cassiopeia and the Pleiades, too. Suddenly a rude voice called out, "Turn out the stars," and overhead they flickered and went out. It was dark as hell again, and lonesome. Then there would be the steady drone of the engines as we pitched and tossed in a man-made storm.

When daylight came and I could see the screen, which was our world, I began to

tense, because the terrain was the approach to Tokyo. As we made our corrections to arrive over the initial point for the bombing run, I heard the rude voice call out, "Turn on the clouds." Then quickly, part of the earth was hidden and dark stratus clouds drifted across the screen. Through a rift in them, I saw the island that was our initial point. I turned to the correct heading, and there was the target ahead—I had studied these landmarks so long on my maps that they were familiar to me. I called my bombardier on the interphone, "It's all yours, George. Take her away." From there, he would fly the ship to the target. The rude voice now called, "Put in the wind drift," and the clouds seemed to drift crossways. I knew then the operator was making it tough. We now were approaching the target with it lined up in the bombight. I heard and felt the bomb-bay doors opening, and my heart beat faster. The ship lurched as I involuntarily pulled back on the wheel.

When George called, "Bombs away," I took the controls away from the AFCE. It seemed just like the time we had bombed Rangoon. I looked out hurriedly into the blankness of the cockpit windows, half expecting to see Zeros with their red-circled insignia gleaming in the sun, but my eyes met only darkness. As I gazed down at the city of Tokyo, I ducked my head, for ack-ack should have been bursting. Then I knew that the only thing which the inventor had missed was an automatic gadget down on the floor to shoot a Very pistol or a Roman candle at us while the operator fired a few firecrackers.

Then the bombs struck! After the time of fall had elapsed, there flashed on the screen a little light which show their point of impact. It was perfect! I actually couldn't control myself—I yelled as loud as I could, for our bombs had scored a direct hit on the Emperor's Palace!

The excitement has been too much for me; I take evasive action for a few minutes on the return flight anyway, but I'm just too fagged out. I turn the ship over to the younger copilot, who didn't see it all, and try to get my nerves settled.

Even after I open the silo door and walk out into the sunshine of Florida, it's going to be hard to settle down to an ordinary existence again. I'm going right down town and buy a local newspaper, for two reasons: First, I want to see what town I'm actually in; and second, I want to see if Tokyo wasn't bombed today by a four-engine bomber.

How to Read Aerial Photos

(Continued from page 126)

gets such as railroad yards, oil tanks, and canal locks are virtually impossible to conceal from aerial cameramen. Locations of chemical works, arms factories, pipe lines, and other objectives are known to industrialists all over the world, and picking them out on reconnaissance photos offers little difficulty. Even when they may be shifted from place to place, the secret is hard to keep. From much-bombed Bremen, the great Focke-Wulf airplane assembly plant was moved to Marienburg in East Prussia, farther than Allied bombers had ever penetrated into Germany. Just the day before Reichsmarshal Hermann Goering was to dedicate one of its new buildings, the U. S. Army's Eighth Air Force spared him the trouble by razing the whole Marienburg plant to the ground. In this case, one of the clearest air photos ever taken leaves no doubt of the havoc wrought by precision bombing.

Less conspicuous clues often reveal the extent of destruction. A factory with a chunk missing or with gaps in its roof probably has suffered heavy damage from a near-by hit and flying debris. Shapes like open boxes are the shells of bombed-out buildings. Tops of walls still standing appear white, because the crumbled surfaces reflect sunlight. A checkerboard pattern of bright spots in the shadow of a wall indicates sunlight streaming through the window spaces of an unroofed structure. An indistinct, blackened heap vaguely resembling the outline of a building signifies a ruin gutted by fire. A white splotch, practically free of shadows, shows where a bomb hit; and signs of damage will radiate from it. If the white scar is more or less oblong, a whole building has been blasted from its site.

By comparing "before-and-after" pictures of bombing, some of which are reproduced here, a beginner quickly gets the idea. And a professional photo interpreter, aided by industrial technicians and statisticians, can estimate with remarkable accuracy the daily loss to the enemy in gasoline or ball bearings; the percentage of his total resources that this figure represents; and the time that it will take to get any reparable plants back into production.

Latest refinements of aerial photography—notably, improved natural-color and relief processes—come to his aid. New color film permits views to be taken from planes speeding faster, or in less favorable light, than ever before. Their realistic hues unmask enemy attempts at camouflage that might go

unnoticed in black-and-white photography.

Relief views, which show objects in three dimensions, take the flatness out of aerial pictures. Here is an ordinary aerial photograph of what looks like a smooth beach, suitable for an invasion landing. A relief picture shows, instead, a high cliff from which a few gunners could mow down any would-be invaders. Probably, signs of relief in the flat picture—such details as stream courses—would prevent a photo interpreter from being misled, but a quick glance at the other view saves time and effort.

As for the man who makes the pictures, it need not be supposed for a moment that enemy forces look on complacently while he photographs their installations. At all costs, their object is to prevent him from getting back to his base with the views. Therefore, it is easy to imagine the frustrated wrath of a group of American airmen in India. At regular intervals, a Japanese airman, whom they nicknamed "Photo Joe," paid them visits. Between clicks of his shutter, he radioed insults in perfect English, confident that they had no plane capable of reaching his high altitude in time to catch him. Then the Yanks stripped a P-40 of everything but guns and climbing performance. Right on schedule, "Photo Joe" reappeared with his taunts—just once too often.

Fortune gave a different twist to a European incident when an American pilot, at the completion of a photographic mission, found an Axis fighter plane closing in on either side of him. Just at the moment their guns spat fire, he climbed sharply. While his enemies shot each other down, he made good his escape!

Freak engagements like this may be rare, but daring exploits of flying cameramen are legion. For there is military information of inestimable value in the pictures they bring back—if you know how to find it.

Chemical Coating Gives Protection to Metals

ZINC and cadmium surfaces become corrosion-proof when dipped in a chemical bath developed by the Rheem Research Products laboratories, Baltimore, Md. The wartime advantage of this treatment is that chromium, the former protective agent, can be transferred to other uses. When applied, the thin solution does not alter the dimensions of metal parts.

Fleet for Invasion

(Continued from page 79)

Two powerful Diesel engines drive twin screws; there also are three auxiliary Diesels which provide power for operating the bow doors, ramp, and ventilating fans. LST's carry a heavy armament of antiaircraft and dual-purpose guns, and are manned by crews of eight officers and 85 enlisted men. They carry large numbers of tanks or other mechanized weapons, and heavy deck loads of trucks, smaller landing craft, or other cargo.

LCT's—*Landing Craft, Tank*—are Diesel-powered steel landing lighters developed from similar British craft. They are a little over 100 feet long, are armed with anti-aircraft guns, and are of such shallow draft that they can drop their bow ramps and land their loads of medium tanks or guns, trucks, or jeeps on even gently sloping beaches. They are built in three sections, so that they may be taken apart for long-distance transportation on LST's or cargo ships.

Originally designed by our Navy to meet British needs, the LCI—*Landing Craft, Infantry*—has become an important vessel of our invasion armada. It played an important part in our Sicilian and Kiska operations. LCI's are over 150 feet long, are as smart-looking as destroyers, and are seaworthy, powerful, and heavily armed. Although they are capable of crossing the Atlantic, they also can be beached in shallow water, and land about 200 doughboys by means of twin ramps which are lowered at either side of their bows.

When the building of the first billion-dollar section of our invasion armada was

undertaken, all shipyards and most boat-building plants were working at full capacity. New sources of production had to be found, and numerous contracts were awarded to industrial concerns, located along inland waterways, which had experience in steel fabrication but knew nothing about ship or boat building. Workers had to be trained. But all who had a part in the big job, down to the newest girl working for a subcontractor turning out the smallest part, were told that they were helping to build "invasion boats." That was enough. They got thousands of landing craft finished in time to make possible our first land offensives against the Nazis and the Japs.

While the boats were being built, the Navy was training crews to man them. Handling landing craft, no matter what their size, in all conditions of weather and surf and against determined opposition from the shore, is a job which takes plenty of know-how and as much courage and physical endurance. Many of the sailors now manning landing boats in active service—a number of them already have won decorations for bravery—received their training at the Amphibious Training Base near Norfolk, Va., or at one of the several other landing-craft training bases in the Chesapeake Bay area. These training establishments all are part of the Atlantic Fleet Amphibious Training Command of Commodore Lee P. Johnson. So is Camp Bradford, also near Norfolk, where troops ready for overseas service are given a brief and strenuous course in invasion techniques.

How Axis Land Mines Work

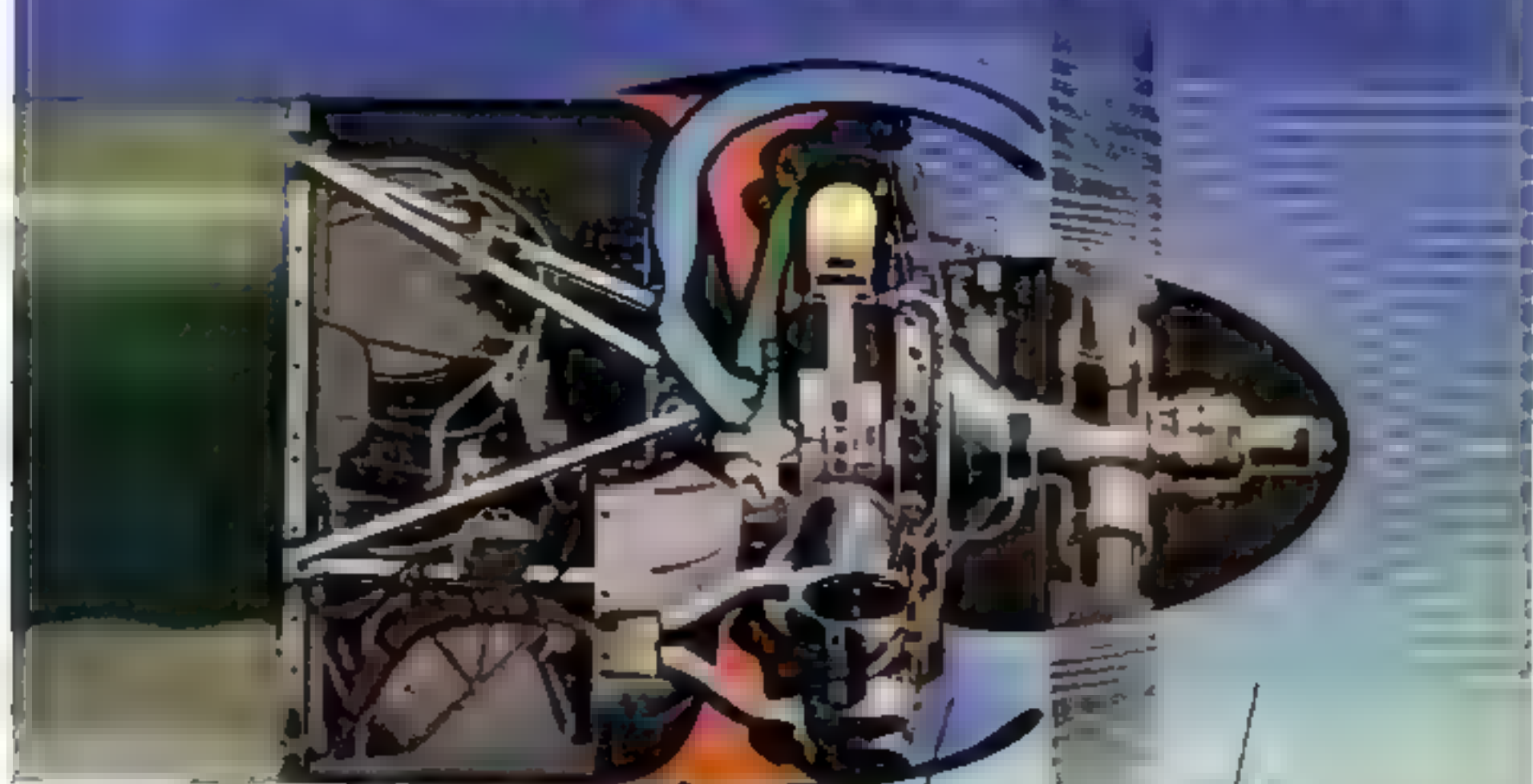
(Continued from page 130)

S mines. Besides their horrible man-killing characteristics, they have a high strategic value in slowing up an enemy attack. The specialists whose job it is to clear them out have resorted to many stratagems—driving a herd of hogs or a flock of sheep through a mined area, bombing it from the air, blasting it with artillery fire, or working it over with bangalore torpedoes, which set off the mines by sympathetic detonation. All these means work with some degree of effectiveness; but eventually the mine fields have to be cleaned out by hand—locating the remaining mines with magnetic detectors, digging them up, removing their firing devices. The process is just as minute in villages deserted by the enemy, where sap-

pers must carefully search for booby traps.

Every move of the Allies into Axis territory raises new problems for our mine experts, and since land mines are essentially defensive weapons, the Nazis are particularly ingenious in their use. But we have learned most of their tricks. Better yet, we have in our own secret arsenals mines which can top the best of those the Axis has thus far revealed. There is no doubt that as invasion progresses the Allied forces will be using penetration tactics to do a job of offensive mining. Then the Axis will find that the terrors packed in their Tellers and S mines were just a small sample of what can actually be stowed away in a bundle of TNT.

WEIGH IN: POWER & MONNAGE OF THE MEN



1. H_2O is a polar molecule. It has a partial negative charge on the oxygen atom and a partial positive charge on the hydrogen atom. This polarity allows water molecules to form hydrogen bonds with each other, which is why water has a high boiling point and a high heat capacity.

3. In enclosure behind engine pressure drops to 7.23 lbs./sq.in. even though temperature is raised to 150° F. One pound now occupies 31.0 cu. in.

2 In rated power flight, plane picks up air at 300 MPH. Impact compresses air to 7.49 lbs / sq in, raises temperature 76°. One pound of air now compressed to occupy 22 cu. in.

1. Standard air temperature at altitude of 20,000 ft. is -12°F ; standard air pressure is 0.75 lbs./sq.in. One pound of air occupies a volume of 24.3 cu. ft.

A Direct Approach to Cooling

All aircraft engines are cooled by air, whether it passes through a radiator containing intermediate coolant, or flows directly across finned cylinders. Wright has produced both types of engines, but today the Cyclone, cooled directly by air, develops more power for its size and weight than any other powerplant of any type.

Years ago, air cooled engines were mounted in the open, without cowling. While this provided reasonable cooling, it created high drag. Present powers and speeds have resulted largely from improved cylinder finning and scientific cowling.

With each increase in number and depth of fins, engine powers have gone up. In 10 years the rating of the Cyclone 9 has been raised 80% without increase in displacement. The latest development in cylinder design, a forged head with machined fins, permits another 15% increase in power.

Better heat conductivity of the forged metal, plus extra deep fins, make these new cylinders the easiest of all to cool.

In cooling an engine, still air is picked up and swept along momentarily at plane speed, then returned to surrounding air. Unless it is ejected by the cowl at approximately the same speed with which the plane picked it up, the forward velocity which it retains represents a serious loss of energy. The reduced cooling effort required by the Cyclone permits reduction of this drag to negligible values in high speed flight, as shown in the illustration.

Simple and direct air cooling is a feature which makes the Cyclone an economical source of power. The payload advantage and ease of maintenance means additional revenue dollars for the operator.

WRIGHT CLONES PAY THEIR WAY

Cyclones and Whirlwinds - Light - Compact - Powerful

ONLINE

Aircraft Engines



MEET YOUR NEW NEIGHBOR...

Everyone knows that the world is growing smaller through the development of Science and Industry — the War is a grim reminder of this fact — but when the job of war is done and the Peace is won the world will become a *Neighborhood of Nations* — working and living together for their mutual betterment.

Radio will serve the world in a measure far greater than ever before — for pleasure, education, safety and convenience of all mankind!

Look to Hallicrafters — they are planning ahead TODAY for your radio TOMORROW — plans born of wartime manufacturing experience and engineering developments.

hallicrafters RADIO

THE ALL OUT EFFORT of the people of Hallicrafters has won for them the honor of being the only radio company far and near to win the Army-Navy Production Award in the 30th time — FIFTY MILLION DOLLARS worth of war production and developments will be built into your new Hallicrafters Radio.



BUY MORE BONDS!

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO
AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.

No Supermen Needed

(Continued from page 87)

tion of any special test equipment that was carried in the first models, the instrument board must carry only a few fuel gauges, air-compressor tachometers, and flight instruments. The jet-engine instruments, of course, would be in pairs for the two units.

As these engines are located near the thrust line of the aircraft, for obvious reasons, the maneuverability must be excellent; engine and propeller torque is absent, and the power thrust is steady and constant. With no propeller-blade pitch to influence performance under varied flight attitudes and conditions, the handling of the plane must be thrilling and effortless. The lack of vibration and engine noise reduces pilot fatigue to a minimum. Even at high speed and at its extreme altitude the craft "acts as most conventional planes do," according to a pilot who has flown it.

Incidentally, the first to fly this American-designed jet-propelled plane was Robert Stanley, chief test pilot of Bell Aircraft, who achieved fame before the war as one of America's outstanding soaring pilots and designers of motorless (and propellerless) aircraft.

With the jets to the rear, none—or practically none—of the jet noise reaches the pilot, who is conscious only of the rushing sound of air about the closed-in cockpit. The propellerless nose also offers an ideal location for armament and is likely to contain a wide variety of guns for the reason that none of them would need synchronization with propellers.

With Bell the pioneers in the use of such armament as the 37-mm. cannon, it is likely that similar firepower will be carried in the new fighter, possibly in multiple units. There might also be .50 caliber machine guns, long a favorite of the AAF for combat use and employed in connection with cannon in the P-38 Lightning, whose nose is similarly devoid of a propeller.

The take-off of the plane, while not unusual, should permit excellent climb angle with no stall danger, for in a jet engine the power is steady and there is no need to contend with changing propeller pitch. New advances in wing design, and the success of the laminar-flow wing in the Mustang P-51 as built by North American, might suggest that a similar airfoil was used here.

Combat damage to the jet units should be no more of a hazard than similar damage to an orthodox power plant. While the performance on one tube, if possible at all, is shrouded in military smoke screens, we may

assume that adequate allowance for such performance has been made.

Certainly, with all power jets out of commission the craft offers no more hazard to the pilot than any orthodox craft now in operation. In fact, there are many advantages favoring the jet-propelled ship in case of a forced landing. There is no heavy engine in the nose to produce vicious spin or dive characteristics, no whirling prop to offer possibilities of further damage, and no nose weight to promote rapid sinking in case of a water landing. The absence of a propeller reduces combat hazard still further.

The performance of the Bell craft in a dive must be phenomenal. With no propeller to hold it back it must build up supersonic speeds rapidly. These have been attained in orthodox craft in spite of the retarding effect of the huge area of the revolving props ahead of them and the large cross section necessary to accommodate the power plants driving them. In the sleek, ultra-streamlined Bell, with no propeller "brake" and plenty of jet power urging the craft on, the dive speeds must be almost incredible.

Ordinary combat maneuvers must be possible, for again this is a military aircraft and the power is normal in action. The thrust from the engines produces a blast of air comparable to the prop stream from a propeller. Only in manner of production is the push from the engines different. The performance of the plane, judging from published reports of calculated jet-aircraft performance, must improve with the altitude. True, at high levels there is not the same density of air behind for the craft to push against, but to offset this there is less density ahead to offer resistance.

How the plane was moved across the continent to the Army field for testing has until now remained a secret known only to the accompanying guards and technicians. Now it can be told, however, that at one time the ship was fitted with a dummy wooden propeller which successfully hid its novel nature, and that the hangar in which it was housed was reported to contain a project for improving sewing machines.

One of the best-kept secrets of the war, the jet-propelled plane still keeps plenty to itself that can not be read between the lines and assumed from common knowledge of aircraft and jet performance. Rest assured, however, that our boys will have no trouble with the new jet planes. Whatever trouble develops from their use will be experienced by their opponents in combat.

Contrary to popular belief, today's slow driving dirties spark plugs quicker. Regular cleaning and adjustment are more necessary. When you need new plugs, get the longer life that is engineered into AC Spark Plugs.



BUY ANOTHER WAR BOND THIS MONTH

The Mars Makes Good

(Continued from page 84)



At Pearl Harbor, vital war cargo is unloaded from one of the auxiliary cargo holds in the wings. If the Mars had been a bomber, as was first intended, these spaces would have been bomb bays. Most of the cargo, however, is stowed in the big fuselage

Though nothing was visible of blacked-out Hawaii below, the line on the big chart showed we had nearly reached the island of Molokai. Navigator Witherspoon and the skipper bent over the big chart-table. Unless we were to land in darkness, we had nearly two hours of flying time to kill, so we turned right on a dog-leg north of Molokai and just idled along for three quarters of an hour or so. When we turned south again, the Southern Cross hung low in the sky over Molokai—an auspicious welcome to Hawaii.

We flew in close to Oahu and circled. Then, dropping altitude without a quiver, we swung around Diamond Head and slid into Honolulu Harbor just as the sun was rising. "Stand by for landing!"

This time we didn't bother to put on life jackets. As far as we were concerned, old "Moby Dick" had made good. With never a bump, we landed on the glassy surface and taxied up to our berth.

The navigator's clock showed 7:42. Chasing the sun, we'd gained 2½ hours on the clock, and our flying time for the trip was 15 hours nine minutes. We knew that with equally good weather Bill would make it next time in about 13.

Out here in Hawaii they stop you in the street to ask questions when they learn you
(Continued on page 208)



The Voice of G-E Research

The Story of "Colonel" L. A. Hawkins

GODFATHER to most of the developments in General Electric's Research Laboratory is Laurence A. Hawkins. He has coined such names as *thyatron* and *phano-tron* for so many electron tubes that he has created a new language! The electrical industry calls it "Greco-Schenectady."



Though he entered Williams College intending to study law, his interest was slanted toward electricity during summer work at the Stanley Electric Co. in his home town of Pittsfield, Mass. So in 1897 he took his new B.A. from Williams to the Massachusetts Institute of Technology, where

two years later he was graduated as an electrical engineer.

Back to the Stanley he went then, and when it merged with General Electric he went to Schenectady as a G-E patent lawyer. In a few years he was made engineering assistant to the director of the Research Laboratory. Later he became executive engineer, a position which he has kept for thirty years.

During these thirty years, Larry Hawkins has translated laboratory science into engineering terms and vice versa. The practical applications of scientific discoveries have been his responsibility, and explaining those applications to the rest of us has been no small part of his job. As the "Larry" of the "House of Magic" shows, which the late Floyd Gibbons broadcast, he became the voice of the laboratory. And he gained such a wide reputation as a story teller that he was made a Kentucky colonel, along with Will Rogers and Irvin S. Cobb!

Larry Hawkins is a firm believer in the "scientific atti-

tude"—the basing of opinion on facts that can be proved. And he's an idealist, too, for he believes that applying this attitude to social and economic problems might, in time, solve them. *General Electric Company, Schenectady, N. Y.*



Laurence A. Hawkins

Hear the General Electric radio programs: "The G-E All-girl Orchestra" Sunday 10 p.m. EWT, NBC—"The World Today" news, every weekday 6:45 p.m. EWT, CBS.

192,000 employees of the General Electric Company are on their jobs producing war goods and buying over a million dollars of War Bonds every week to hasten victory.

GENERAL ELECTRIC

100-704-111



THERE'S BEEN A BIG CHANGE

ONE REASON why moderns wear fewer clothes is because they must move faster than folks did in the old days. The tempo of things has changed.

But changes haven't all been a matter of subtraction. In the case of tapered roller bearings, a new, faster-moving age called for addition—addition of rollers to stand heavier loads and shocks. Tyson Heavy-Duty Bearings answer that need.

Tyson actually added *thirty percent more rollers*, on the average, size for size! This single improvement has virtually doubled bearing life for Tyson users. For every heavy-duty job, Tyson "All-Rolls" Bearings are the most advanced . . . toughest . . . longest lived.

* * *

The big name in bearings today is . . . TYSON!



TYSON BEARING CORPORATION, MASSILLON, OHIO

COUNT THE ROLLS - THE ROLLS COUNT

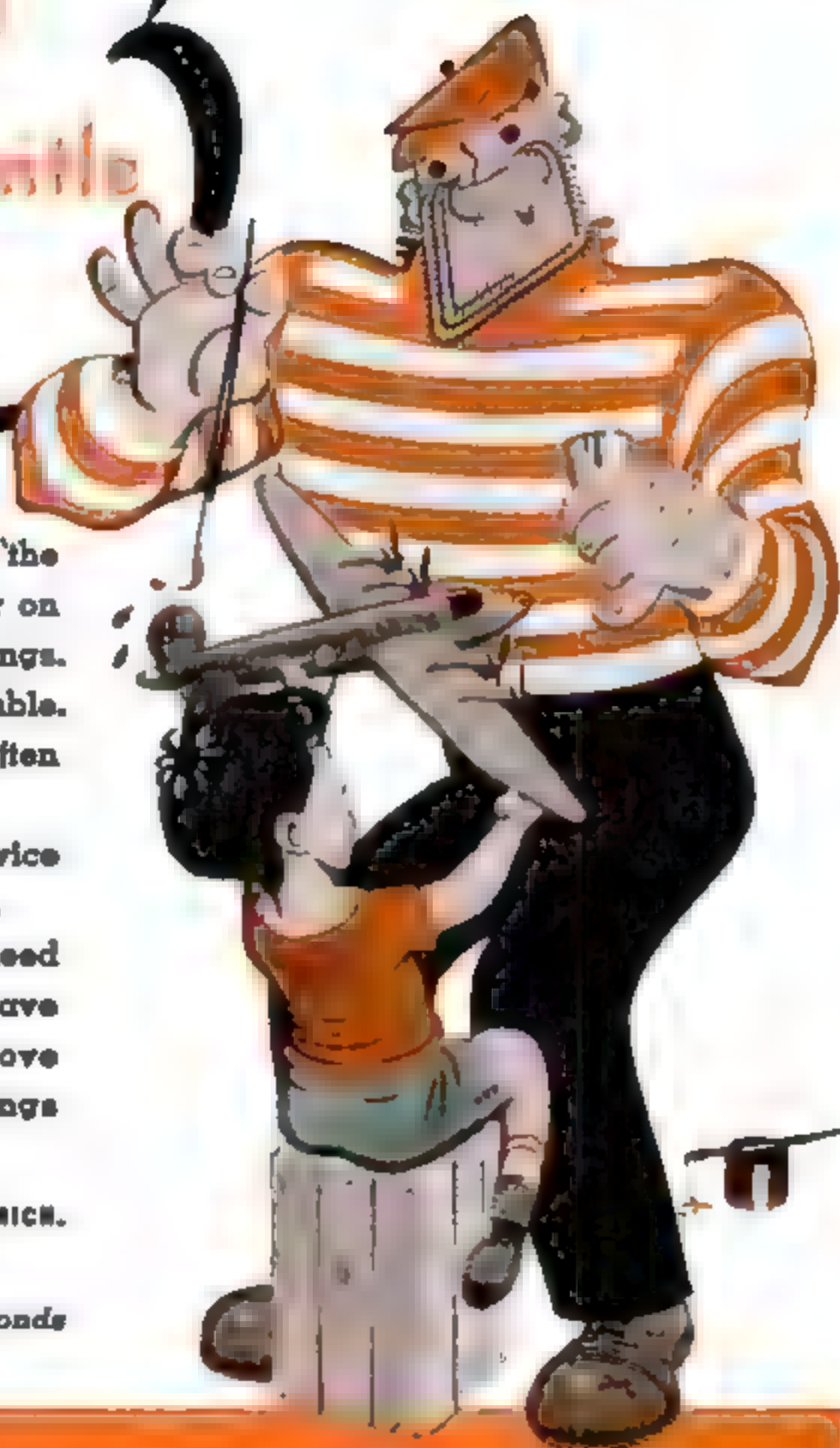
Tyson

TODAY'S HEAVY-DUTY BEARING



★ LET'S ALL BACK THE ATTACK ★

Tough
but oh so gentle



● If you expect your car to outlast "the duration," keep an eye and an ear on the engine—especially the piston rings.

Worn-out rings bring double-trouble. They waste oil and gasoline, and often cause dangerous cylinder wear.

It's wise to have your motor service man inspect your engine regularly.

He will tell you when the rings need replacing and show you how to save oil, check cylinder wear and improve engine performance—with Hastings Steel-Vent piston rings.

HASTINGS MANUFACTURING CO., HASTINGS, MICH.

Hastings Mfg. of Canada, Ltd., Toronto



★ It's a privilege to buy War Bonds

HASTINGS

Tough on oil-pumping · Gentle on cylinder walls



FINISHING TOUCH ...TO SPEED THE GOOD SHIP

HERE you see a ship's propeller blades being given a last-minute dressing—to add that fraction-of-a-knot speed which may mean the performance of some vital war errand in the nick of time.

As on thousands of equally unusual jobs, there is no substitute for the combination of human skill and *The right file for the job.*

With metals, alloys and other materials increasing in variety, the latter becomes a more and more important requisite—in shipyard, plane factory, industrial plant, machine shop, or tool room.

Nicholson and Black Diamond brands comprise literally *thousands* of kinds, cuts and sizes of files. Included are many special purpose files for such materials or operations as stainless steel, aluminum, brass, lead, plastics, foundry castings, die castings, die making, lathe filing, saw sharpening. Guarantee: *Twelve perfect files in every dozen.*

"FILE PHILOSOPHY," A 48-page Book, Free — Invaluable to shop foremen, machine and repair shop operators, mechanics, mechanical "trainees." Profusely illustrated, high-lighted with information on kinds, use and care of files. Address:

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FILES

FOR EVERY
PURPOSE

NICHOLSON
U.S.A.
MADE IN U.S.A.

The Mars Makes Good

(Continued from page 204)

came over in the Mars. Hawaii is aching to know all that military secrecy will permit to be known about the planes that speed passengers and cargo across the vast reaches of the Pacific.

Today, Hawaii teems with uniforms. She is the great advance base in our island-to-island campaign as it gathers strength to drive the Japs from the South Pacific and back upon the Land of the Rising Sun. Pearl Harbor and Hickam Field are among the greatest air bases in the world. A never-ending line of planes and ships cuts across the 2,400 miles that separate these islands from the mainland, and from these islands other lines stretch out like fingers to every point where American troops are fighting in the Pacific. When peace comes, Hawaii will again be what she used to be—the crossroads of commercial traffic between us and the Orient.

Hawaii knows that flying is here for all time. The war has made this island people intensely air-minded. Steamship companies are already planning to supplement their service with fast air lines. They speak of bringing passengers from the mainland here by air for as little as \$125, and Hawaiians are intent on learning what kind of ships will be landing here in those days to come. Some believe they will be big land planes like the Douglas C-54, or big, fast ships like the Liberator, which can span the distance to the mainland in nine hours. But many feel they will be giant sea birds like the Mars. They point out that the big land transports must carry four or more tons of landing gear not needed on an ocean hop, that they are voracious gas-eaters; that they require tremendous, deep-laid runways on which to land with a full load, while the big flying boats can land on any good-sized lagoon—of which there are many not only in these islands but all through the South Pacific.

Not very fast, but roomy and comfortable, able to carry far more weight than any other plane yet seen, ships like the Mars may be our luxury airliners for transocean travel after the war.

Subscribers in the armed services who notify us of change of address are requested to give us the key symbols appearing on the wrapper in which the magazine is received.



When driving nails in painted walls,
Your plaster—has it cracked?
Well, first apply some Texcel Tape,
Which keeps the wall intact.

And if the sweeper handle breaks
The work goes on as planned;
It gets a temporary mend
When Texcel Tape's at hand.



For pages torn in magazines,
In rare old books and such,
Just mend the tear with Texcel Tape—
It sticks with just a touch.

For Texcel is an improved tape
Whose 'stick-um's' bonded on.
It won't come off, it won't dry out
Before the judgment dawn.



Since all the Texcel Tape that's made
Is being used for war,
Buy Bonds and Stamps 'til Victory
Returns it to your store.

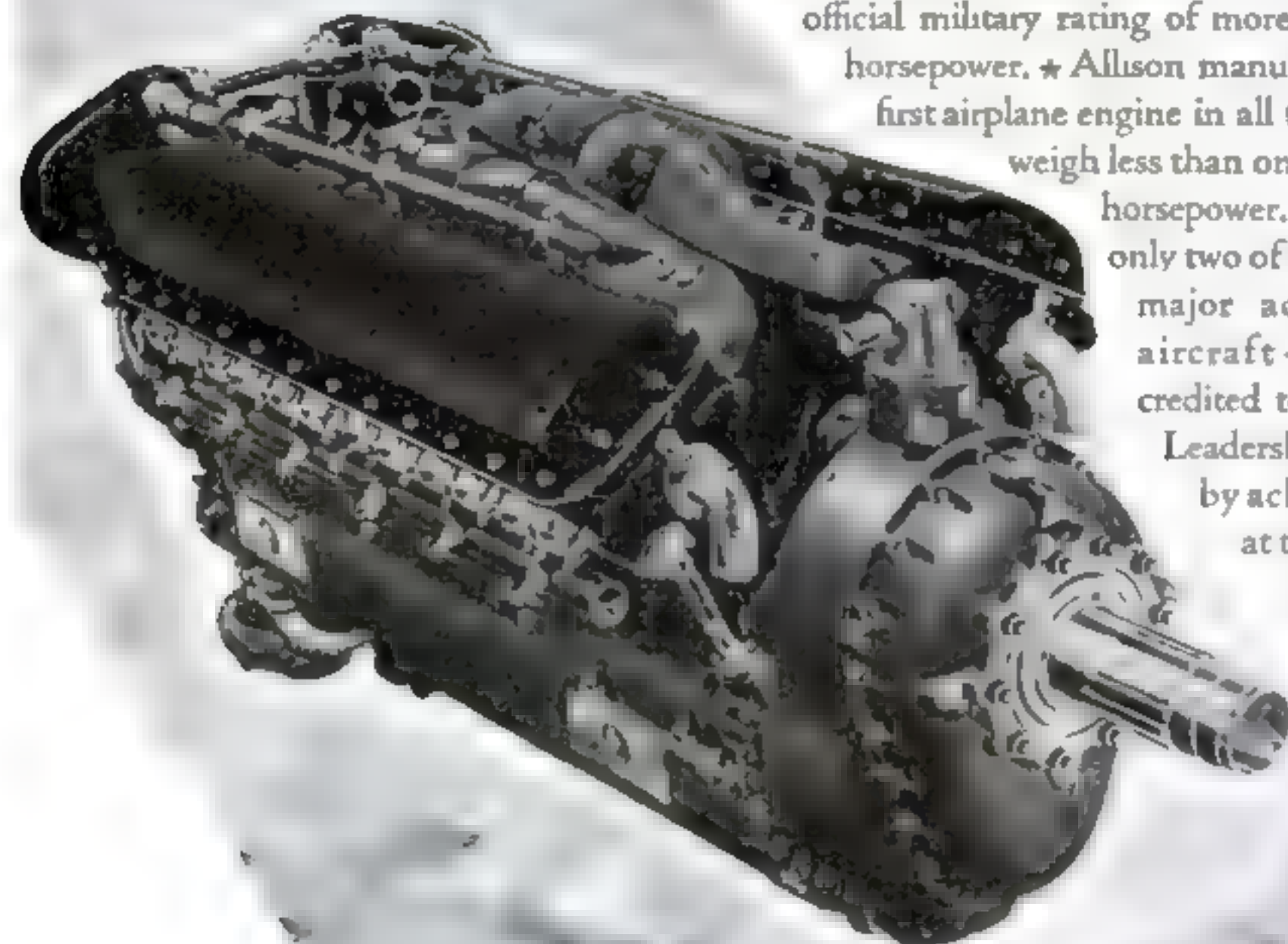
Made by
Industrial Tape Corporation
A Division of
Johnson & Johnson
New Brunswick, N.J.

Texcel Tape

CELLOPHANE TAPE — STICKS WITH A TOUCH

LEADERS DO THINGS FIRST

Leadership rests upon the ability to foresee, to develop, and to achieve — first. ★ On that critical basis, weigh the position of the Allison engine. ★ Allison built the first aircraft engine in the world to receive official military rating of more than 1,000 horsepower. ★ Allison manufactured the first airplane engine in all the world to weigh less than one pound per horsepower. ★ These are only two of the thirteen major advances in aircraft - powering credited to Allison. ★ Leadership is earned by achievements at the forefront of development.



Every Component of the
GENERAL MOTORS SYMBIOTIC
OF THE AIR - No Network

LIQUID-COOLED AIRCRAFT ENGINES

Allison
DIVISION OF



POWERED BY ALLISON:

P-38-Lightning • P-39-Arrow • P-40-Warhawk • F-4U Corsair • P-51-Mustang

KEEP AMERICA STRONG
BUY WAR BONDS

SCREWBALL IDEAS ON BATTERY CARE

#1

Here's a lulu straight from the squirrel cage. Move up your idling speed to make the generator deliver maximum output. Yes, it might save you a recharge, but man, how it eats those "A" coupons up!



but... THE WISE WAY IS PERIODIC RECHARGES!

RESTRICTED driving is hard on batteries. Rationed mileage keeps them from getting a normal recharge from the generator, and can cause serious starting trouble unless certain precautions are taken.

Keep your battery in tip-top shape by letting an experienced Exide Dealer give it a check-up every two weeks. In many cases, periodic recharges are essential, and with them, your Exide Dealer puts off the day when you'll need a new battery. When you must get a battery, get a dependable, long-lasting Exide. Buy to Last—Save to Win.

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia 32

Exide Batteries of Canada, Limited, Toronto



- 1 Don't buy anything you can do without.
 - 2 If you MUST buy, insist on dependable, long-lasting merchandise.
 - 3 Take care of the things you have. Make them last.
- These conservation rules save materials for war production, help curb inflation, give you more money to invest in War Bonds.

EXIDES ARE USED IN MORE THAN 100
APPLICATIONS BY OUR ARMED FORCES



The Soldier and the 10-minute "break"...



AFTER THE COMMAND, "Fall out to the right of the road," the Soldier dropped down on the grass, unscrewed the top of his canteen.

"Water tastes good right now, don't it?" somebody said.

"Yeah, I suppose," said the Soldier. He lit a cigarette. "But for water to really wet a whistle right, gimme a certain old tin dipper."

"When I was home," the Soldier went on, "I'd always go hunting with a couple of the fellows out to Harry Olsen's farm—swell hunting country. Pheasants, rabbits, partridge..."

"What's about that water?"

"Well, Harry has an old tin dipper hanging on the pump. And when we came back from hunting all morning, we'd head for that old dipper. And boy!—water out of that dipper always tasted better than anywhere else. I wish I was there right now!" ...

~ ~ ~

Remington's part in speeding peace is, of course, to continue to furnish Uncle Sam with military supplies. To give you some idea of what we have been doing...

1. For months on end, we were producing 30,000,000 rounds of military small arms ammunition per day.

2. And we were producing, per day, more than enough military rifles to equip an entire infantry regiment at full fighting strength.

But sometime—soon, we hope—Remington will be serving sportsmen again with shotguns and rifles, Remington Express shells, Remington Hi-Speed .22's with Kleanbore priming, and Remington big game cartridges with Core-Lokt bullets. Remington Arms Company, Inc., Bridgeport, Conn.

"Express," "Kleanbore," "Hi-Speed," and "Sportsman" are Reg. U. S. Pat. Off.; "Core-Lokt" is a trademark of Remington Arms Co., Inc.

Remington



Chasing Echoes on a DE

(Continued from page 56G)

who bilged out in his third year because of eye trouble, but you wouldn't have thought it, watching him all day scanning the horizon. It was cloudy now, and his deep red face, starting to leather up, was etched with the white profile of the sunglasses.

He had reason to be proud, and not only of his ship, for here he was in command when most of his classmates were still execs on tin cans. But he had earned it the hard way. At Detroit, where he made auto springs, he kept up with the Navy on the local training ship. And in the first year of our war, he was one of the first—perhaps the first—to take a 110-foot sub-chaser island-hopping across to the South Pacific.

The commodore also seemed pleased. Sailing with us as a passenger was Commander R. N. Norgaard, who had commissioned the ship and trained her crew on the shakedown cruises. Now he was making a trip across to absorb atmosphere and experience before taking command as commodore of a division of DE's.

Nodding approval, he went below for a game of acey-deucey with his crony, Lt. Claude Corbus, the engineering officer, and the only other regular U.S.N. officer aboard. It was all right, the way the Naval Reserve boys were taking over.

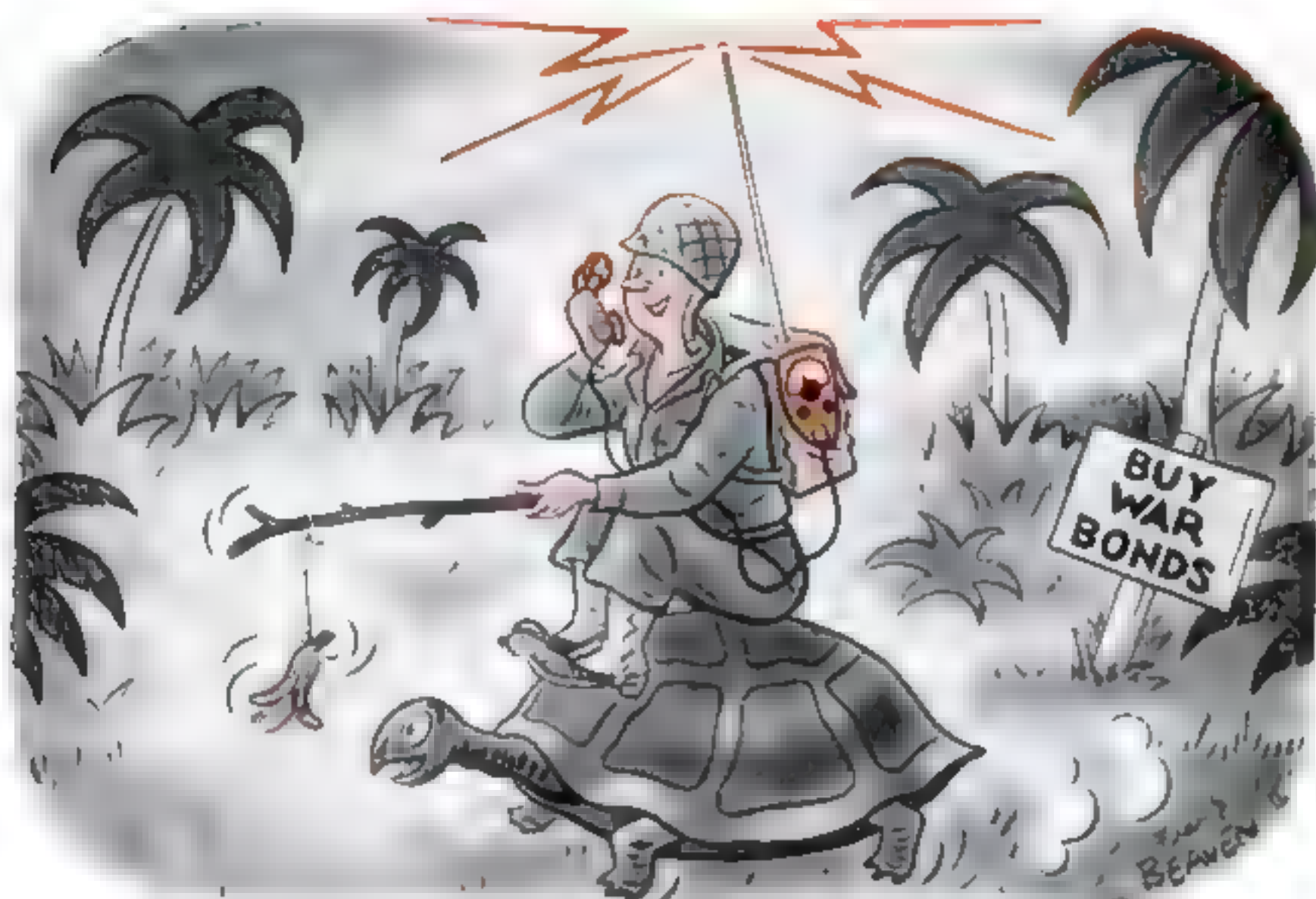
In spite of all the scientific devices of this war, it is still the human factor that counts. Whether you consider the fiasco of the Pearl Harbor listening devices or the finesse of Bob Denniston's ear, there's always a man on the job. Science is not making robots of us all. It is increasing our range, our power, our exactness, our speed of perception; and with every such increase comes an increased demand for the alertness, the precision, and the responsibility of the individual.

A couple of years ago, Bob Denniston was a young lawyer fresh from the University of Alabama. He had just hung out his shingle at Mobile when the war interrupted his career. He already had learned sailing on the Gulf of Mexico, and soon was at anti-sub school in Florida, and on an SC boat.

This story has been mostly about Bob because he is the anti-sub officer, rather than because of other special qualities. It might have been about Dave Acheson, a Harvard-Yale specialist in literature, jack-knifed in the sound hut, listening for a "poop-poop-poop" with ears attuned to the cadences of eighteenth-century verse. Or about Lt. Martin Victor, a young Wall Street lawyer; or Lt. Bailey Swenson, a

(Continued on page 216)

LIGHTER MOMENTS with **fresh Eveready Batteries**



"Tell the Mess Sergeant to look up the recipe for turtle soup."

POWERFUL little "Eveready" "Mini-Max" batteries make the armed forces 2-way radios practicable. The reason your dealer has none on his shelves today is that our entire production is now going to the armed forces.

You, personally, can save a soldier's life by giving a pint of blood to the Red Cross. They maintain Blood Donor Centers in 35 cities. Call for an appointment now!

The words "Eveready" and "Mini-Max" are registered trade-marks of National Carbon Company, Inc.





Guardian Angels

The fireworks are all over. The "Sad Sack" is nearly home. A few minutes more, and she'll put her crew down safe on a friendly field.

She went out this morning full of fight, with her belly full of bombs... all four motors roaring defiance at every German in Italy.

She hammered the Nazi railyards at Terni, and left them a tangle of wreckage.

But she had to take a few on the chin to do it.

When the escort fighters picked her up, the "Sad Sack" was on the spot... straggling behind her formation, with one engine knocked out by flak... trying to fight off a Focke-Wulf pack that was swarming in for the kill.

The sweetest sight her crew ever saw was that escort of P-38's... screaming down to the rescue with their noseguns squirting fire... chasing the Jerries out of there or shooting them down in flames.

That's why bomber-men call them "Guardian Angels", these escort fighter planes. For they bring back bombers and bomber crews to fly and fight again!

And that's the kind of team you'll be on when you wear A.A.F. wings. Pilots, Navigators, Bombardiers, Gunners, doing their job together... flying and fighting for the team, "the greatest team in the world!"

U. S. ARMY RECRUITING SERVICE



MEN OF 17...

You can get ready now for your place on the great A.A.F. flying team. Go to the nearest Aviation Cadet Examining Board... see if you can qualify for the Air Corps Enlisted Reserve. If you qualify, you will receive the Enlisted Reserve insignia... but will not be called for training until you are 18 or over.

When called, your special aptitudes will be studied further to determine the type of training you will receive. For the A.A.F. not only builds a combat crew from the pick of the crop, but carefully selects for each position the man with the best capabilities for the job... and then adds the thorough training which makes this all-star team the world's finest.

Prepare yourself in advance by taking C.A.P. Cadet Training as given by your local Civil Air Patrol. Also see your High School principal or adviser about recommended courses in the Air Service Division of the High School Victory Corps. Both afford valuable pre-aviation training.

(Essential workers in War Industry or Agriculture—do not apply.)

For information regarding Naval Aviation Cadet Training, apply at the Naval Aviation Cadet Selection Board in any Office of Naval Officer Procurement, or at any Navy Recruiting Station; or if you are in the Navy, Marine Corps or Coast Guard, apply through your commanding officer. This advertisement has the approval of the Joint Army Navy Personnel Board.

"KEEP 'EM FLYING"

FLY AND FIGHT WITH THE

GREATEST TEAM IN THE WORLD



INDIAN
TRAIL BLAZERS



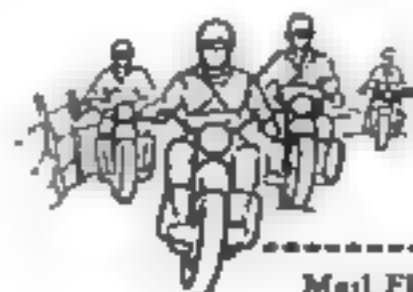
Which Way Adventure

Take the right fork...or the left...there's fun, fellowship and the greatest sport in the world just waiting for you when you own an Indian, America's most famous motorcycle. With an Indian, you'll enjoy a thrilling new freedom...away from plodding traffic lanes. You'll be able to explore those out of the way places no car can ever get to. On smooth highways or country roads...you'll find that your Indian ride will be incredibly smooth. You'll experience a feeling of safety and confidence you never believed possible. Make your plans now

so that when this war is won, you can enjoy motorcycling at its finest, astride an Indian.

INDIANS ON THE WARPATH

Right now, all new Indian Motorcycles go straight to war, and what a fighting record they're turning in! But new, improved, postwar Indians are already being blueprinted. *They're the motorcycles to wait for!*



**BUY WAR BONDS NOW
TO BUY AN INDIAN LATER**

Indian Motorcycle Company
Springfield, Massachusetts

Mail FREE copy of exciting Indian News.

Name.....

Address.....

City.....State.....

PS-4

Indian

MOTORCYCLES

APRIL, 1944

Buy War Savings Bonds and Stamps regularly.

215

Some things haven't changed!

LHS

STERNCREST

STERLING

Every pipe produced from genuine imported Mediterranean briar of pre-war quality, and shaped by the skilled hands of master craftsmen to be "A thing of beauty and a (smoking) joy forever". Sterling Silver band; solid rubber bit. Every pipe numbered, and registered by LHS, as your guarantee of pipe perfection.

\$5

Smooth and
Antique
Finish

Many hand-
some medals.



"Perfection . . . in a Pipe"

LHS STERNCREST 14K

The custom craftsmen of LHS select the very choicest grains for these patrician pipes. They finish them by an exclusive process that brings out the full beauty of the briar,—circle them with a band of solid gold. Truly, "Perfection—in a Pipe"

\$7.50

L & H STERN, Inc., Stern Bldg., Brooklyn, N. Y.

Makers of the famous

LHS Ultra-Briar \$10 Certified Pures \$3.50 Superfine Pures \$1.50

Put this in your
pipe and smoke it



Chasing Echoes on a DE

(Continued from page 212)

Houston architect; or Ensign Henry Huettner, whose efforts have been transferred from the enforcement and interpretation of wage-and-hour regulations in Mississippi to the interpretation of Navy codes. Or Charlie Hanson, the seasickest national pistol champion that ever left the University of Southern California at Los Angeles to become an ensign.

You may not think there's anything heroic about a seasick landsman standing watch in the North Atlantic, skirting the edge of a tropical hurricane, with the ship rolling to a 40-degree angle. But take a maiden trip on a DE and you'll know there is.

Even the man on watch probably could spare some sympathy for the lad from the Tennessee mountains who sits below decks, braced against a bulkhead to keep from rolling over, swaying in agonized rhythm with the heaving ship, a dog-eared letter from home in one hand and a bucket in the other.

But even that Tennessee lad, you may be sure, is an old sea dog by now, as he stands his North Atlantic duty in stiffening clothes while the spray glazes the mask which shrouds his face. It's a far cry from a home in the south to roaming in the icy north, but unlike the illustrious Sam McGee, these boys have a blamed good reason and they know it.

Already they looked a bit like sea dogs as they strolled up the street on their first liberty in a foreign port, relaxed and easy with a rolling gait. All except Bob. When last seen, he was hurrying up the quay with a brief case under his arm, bound for the British anti-sub tactical school. That boy has a purpose in life. And until he gets his submarine, nothing is going to stop him.

So there's the DE 675, a smart, pert ship, and a good one. She's worthy of the Navy flyer whose name she bears—a lieutenant (j.g.) killed in the Battle of Midway. And so, you may be sure, are the men in her.

Water-Resistant Tape Seals War Shipments

SEALING tape that is water-resistant is the crowning achievement of our effort to package supplies so that they arrive overseas in the finest condition. Made by the McLaurin-Jones Co., Brookfield, Mass., the tape is moistened with a special solvent and withstands actual immersion in water.

Douglas Craftsmanship at its Best



THE LEGIONNAIRE

THE BUCKINGHAM

Buy them for Easter... Wear them the Year-round! W. L. Douglas Shoes are handsomely styled for important occasions — expertly made to withstand the wear and tear of everyday use. Join the men of sound judgment who are investing their shoe ration stamps in the correct styling, comfort, and economical long wear of W. L. Douglas Shoes—Craftsmanship at Its Best!

\$6.50* \$8.50
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Douglas Shoes
W. L. DOUGLAS SHOE CO., BROCKTON 15, MASS.

Stores in Principal Cities—Good Dealers Everywhere



BUY ANOTHER
BOND TODAY!

TODAY...over there



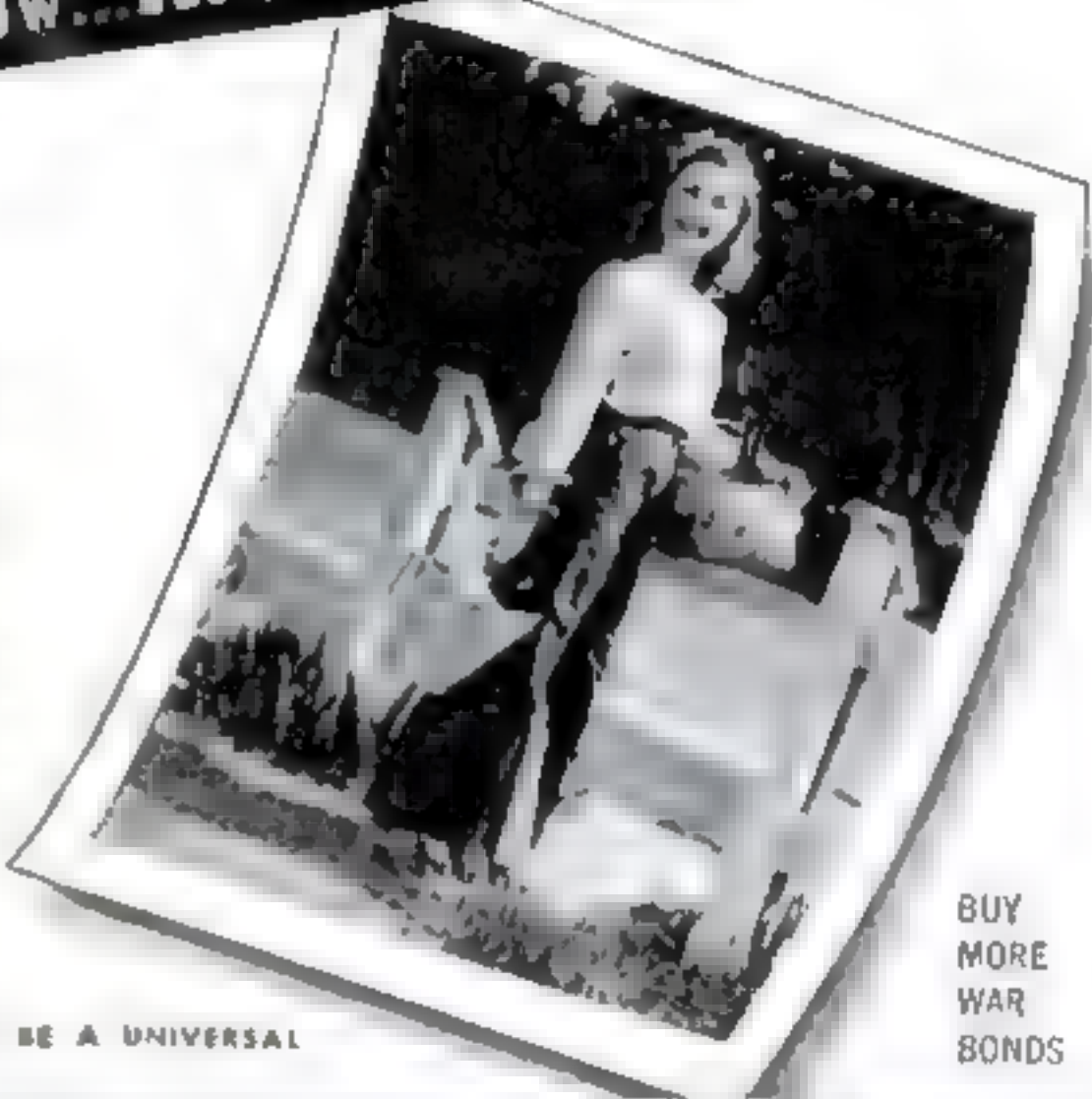
here we are enclosing it for you
 Boy was it a honey? I think I'm
 getting better with every shot I
 a guy only had enough time left
 over from this war business, I bet
 I'd be taking some prize winners!
 Put this with the rest of the



TOMORROW...back home



**FAR MORE PRICELESS SUBJECTS
 AND FINER-THAN-EVER CAMERAS
 TO TAKE THEM WITH!** Yes, soldier!
 When there is "time left over from
 this war business," everybody will
 take better pictures. Until then we
 are working 24 unceasing hours a
 day to produce fine optical instru-
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 thanks to new methods pioneered
 in making instruments of highest
 precision for war, Universal can
 promise after Victory cameras and
 photographic equipment of excel-
 lence hitherto undreamed of.



**BUY
 MORE
 WAR
 BONDS**

EXPECT YOUR NEXT NEW CAMERA TO BE A UNIVERSAL



*There's only one
 day we're
 prouder of*

UNIVERSAL CAMERA CORPORATION

NEW YORK CHICAGO • HOLLYWOOD

Peacetime Manufacturers of Mercury, Cinemaster, Corsair Cameras and Photographic Equipment

AFTER THE WAR IS OVER

AT fighting fronts or on production fronts — the desire for motorcycling thrills still lingers. And whether fellows wear campaign ribbons or Army-Navy "E" pins, their day dreams run about like this letter:

"In 1935 I bought my first '74' which I rode 5 years and turned over a good many miles of the best fun I ever had. After the war is over I've planned a trip that will take me over every state in the Union and will fulfill all my old dreams of a real outdoor trip!"

You bet! The days of long trips, race meets, hill-climbs and all other fun-packed motorcycling events will come again! Plan to be riding with the rest of the gang on a brand new Harley-Davidson — so Buy War Bonds NOW!

*Write for free copy of ENTHUSIAST MAGAZINE,
filled with motorcycle pictures and stories.*

HARLEY-DAVIDSON MOTOR CO.

Department PS, Milwaukee 1, Wisconsin

**HARLEY-
DAVIDSON
MOTORCYCLES**

HARLEY-DAVIDSON MOTOR CO.
Department PS, Milwaukee 1, Wisconsin

Please send at once free copy of 24-page
"Enthusiast" Magazine, filled with motor-
cycle action pictures and thrilling stories.

Name _____

Address _____

City _____ State _____

**SEND COUPON
NOW**



IS YOUR SCREW DRIVER EXCESS BAGGAGE?

MOST people use screw drivers for so many different things that when they come to driving screws no self-respecting screw will take the punishment. This can be avoided with a sharpening stone. Best for this and for keeping other edged tools in shape—is a Carborundum Brand Silicon Carbide Combination Sharpening Stone. One side is of coarse grit for dull edges. The fine grit on the other side puts on a keen, smooth-cutting edge that makes the work go better.



*These stones are available
at your dealer's*

Ask for Carborundum Brand Silicon Carbide Sharpening Stone No. 109. And write today for your free copy of the booklet, "Short Cuts To Better Work For The Homecraftsman."

CARBORUNDUM



Dept. 5-44

THE CARBORUNDUM COMPANY

TRADE-MARK
Niagara Falls, N. Y.

(Carborundum is a registered trade-mark of and trademarks manufactured by The Carborundum Company)

BEFORE STARTING DIRTY WORK

Rub on
"PRO-TEK"
like a
cold cream



When
through work,
grime and paint
wash right off

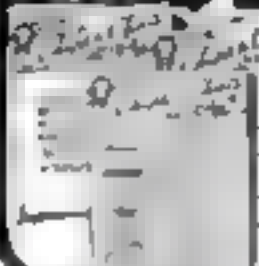


It acts like an
invisible glove



DU PONT
PRO-TEK
HAND PROTECTIVE CREAM

FREE... TO HOME CRAFTSMEN



A FULL YEAR'S SUBSCRIPTION TO
CONSTANTINE'S *Chips & Chats*

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DRILL PRESS OWNERS!

HERE'S 1 TOOL WITH 5 DISTINCT USES



**THE BARRON MULTI-PURPOSE
ROTARY WOOD PLANER**

PLANES & SURFACES • PANELS & BEADS • **\$750**
ROOTS & GROOVES • RABBETS • TENONS COMPLETE

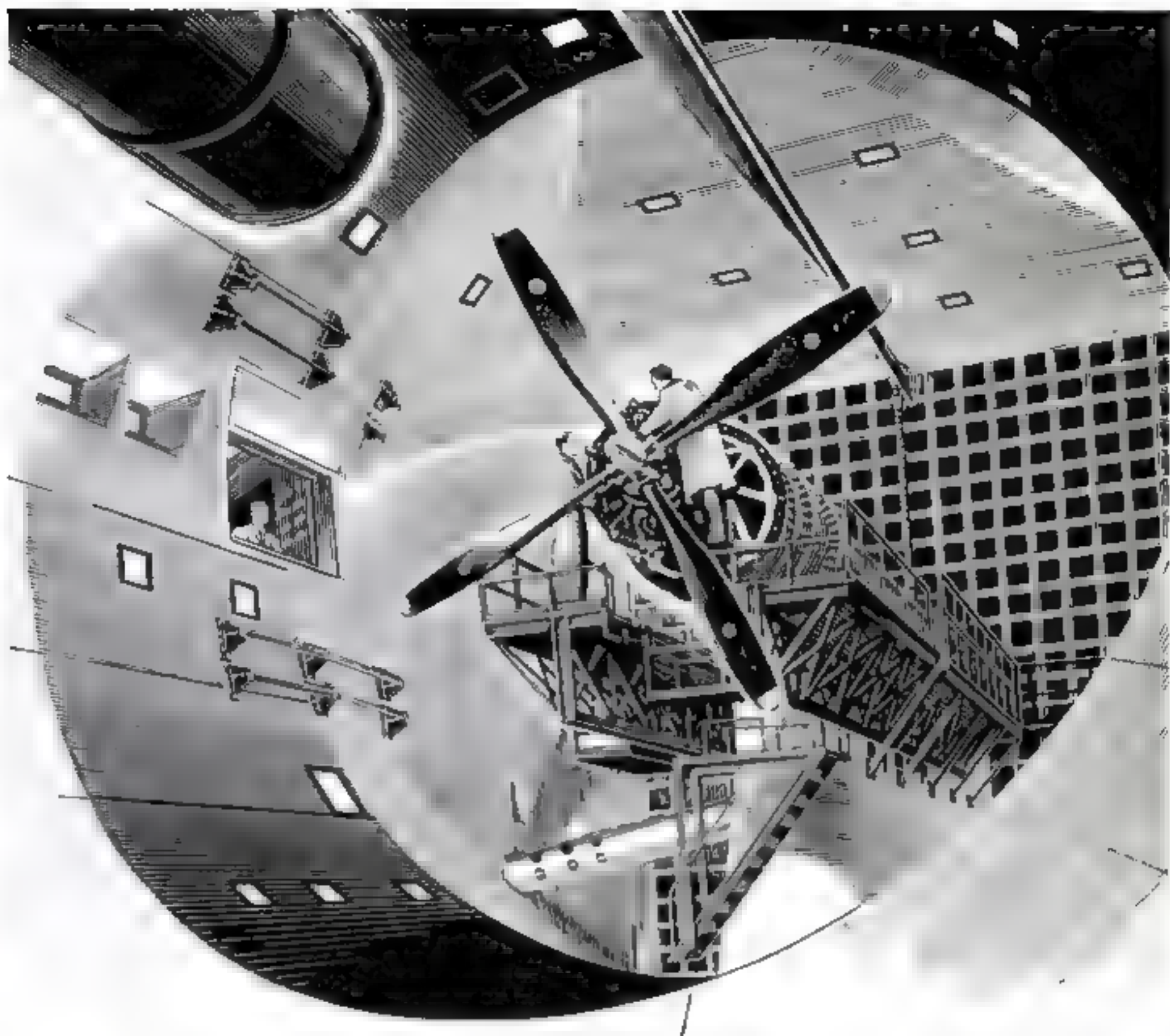
Converts ANY drill press to a time saving low cost planer, paneler, tenoner, etc. Surface finishes all types of tough grained and knotty surfaces to agree smoothness. Safe! Guaranteed harmless to drill press. Thousands now in use. **SOLD ON MONEY BACK GUARANTEE.** Full refund on 5 day trial. Ship prepaid on receipt of \$7.50 or C.O.D. YOU RISK NOTHING. Free literature.

**STEEL TOP AUXILIARY
DRILL PRESS TABLE**

Has 300 sq. in. smooth work top surface. Equipped for sharpening many of the important workshop tools. **Save a tree. Buy at \$5.95**



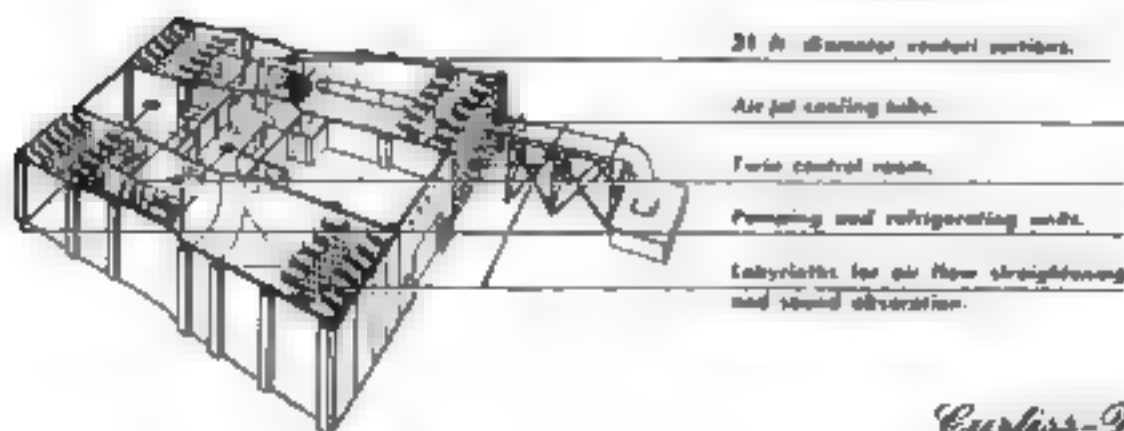
BARRON TOOL CO., INC.
370 Architects Bldg. Detroit 1, Mich.



proving ground for the big blades

Stepping far ahead of current engine and aircraft design, the new Curtiss twin test cells have been built for the express purpose of developing the huge blades of the future. Propellers up to 30 ft in diameter may be tested on either liquid or air-cooled engines with ratings up to 5000 HP. A scientifically designed venturi section eliminates turbulence of air. A combination of cooling systems permits precise control of engine operation.

The new cells are the largest privately owned propeller test facilities in the world. Here in the convenience of a ground laboratory, streamlined air flow and vibration conditions similar to those encountered in flight are closely duplicated.



30 ft diameter venturi section.

Air jet cooling tubes.

Engine control room.

Pumping and refrigerating units.

Labyrinth for air flow straightening and sound absorption.

CURTISS

ELECTRIC
PROPELLERS

Curtiss-Wright Corporation, Propeller Division



**"Good Pictures"
BRING YOU TOGETHER**

EACH picture you take of WAACS, WAVES or SPARS, Soldiers, Sailors or Airmen, is a good picture of Americans at war. Your Argus will give you a personal record of the determination of Americans to win the war.

Use your Argus with care. Save vital film and make each picture a "Good Picture."



SWEEPSTAKES
OFFER AS DIRECTED

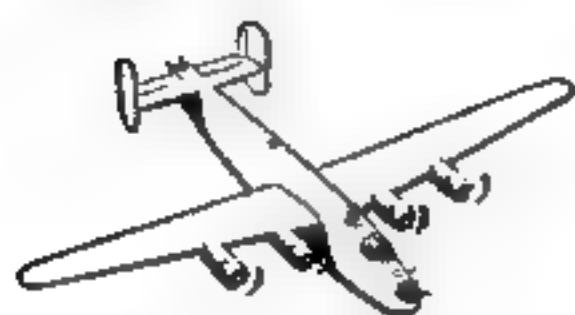
"Good Pictures"

This 36 page booklet is published by Argus to help solve the problems of exposures, lens, films, etc. Get your copy by sending 25c to Argus, Ann Arbor, Michigan, Dept. S.

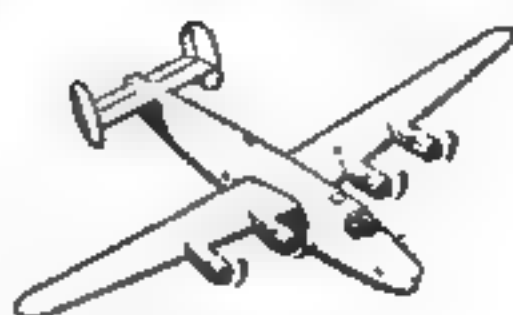
Fine American Cameras



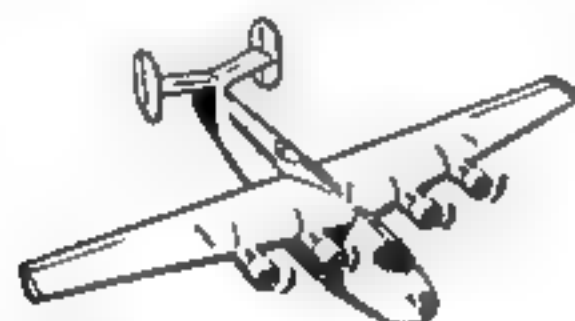
From Flying Jeeps to Leviathans of the Air



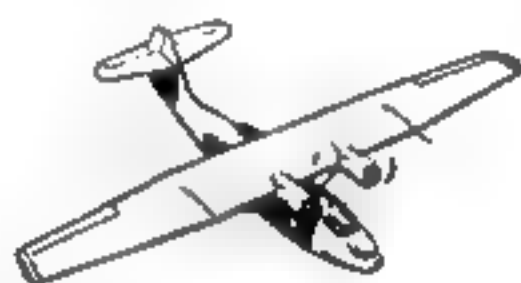
LIBERATOR . . . 4-engine bomber



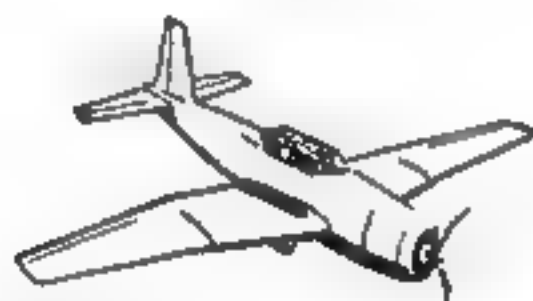
LIBERATOR EXPRESS . . . transport



CORONADO . . . patrol bomber



CATALINA . . . patrol bomber



VALIANT . . . basic trainer



VENGEANCE . . . dive bomber



RELIANT . . . navigation trainer



SENTINEL . . . "Flying Jeep"

WHEN VICTORY has been won, Consolidated Vultee Aircraft Corporation will be in a position to

provide the postwar equivalent of these planes, from small "air flivvers" to trans-oceanic cargo-and-passenger planes.

CONSOLIDATED VULTEE

San Diego, Calif.
Vulsee Field, Calif.
Tucson, Ariz.

Fort Worth, Texas
New Orleans, La.
Nashville, Tenn.

Louisville, Ky.
Wayne, Mich.
Dearborn, Mich.

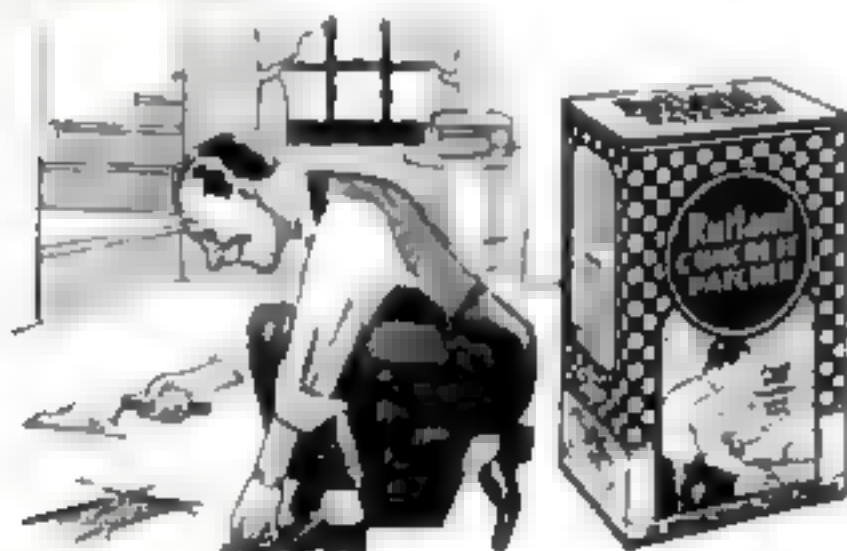
Allentown, Pa.
Elizabeth City, N. C.
Miami, Fla.

Member, Aircraft War Production Council



CRACKED WALLS

You don't have to be an expert to mend cracked walls with Rutland Patching Plaster. Just mix Rutland with water . . . wet the old plaster . . . and apply with knife or trowel. Rutland is the *original* ready-to-use patching plaster. Sets without shrinking or cracking. Extra fine and white. Makes a patch as smooth and lasting as the wall itself.



BROKEN CONCRETE

Don't let small breaks in cement floors, walks, walls, etc., get larger. Mend them promptly with Rutland Concrete Patcher. Just mix with water and apply with trowel.

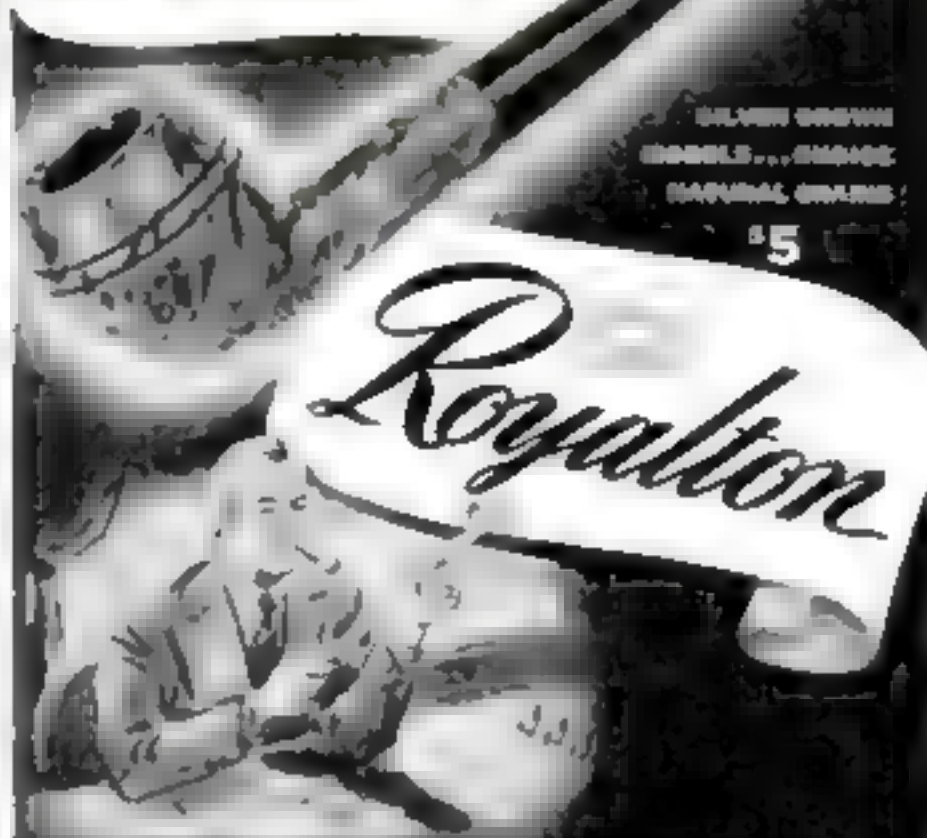
RUTLAND

REPAIR PRODUCTS

Rutland Fire Clay Company, Rutland, Vt.

Buy War Savings Bonds and Stamps regularly.

*For Men Who
Really Know Pipes*



No man can appraise the intangible asset of a truly fine pipe—or evaluate the dreams and reminiscences, and the contentment derived from its smoking . . . But many men know such a pipe and ask for it by name—Royalton.

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ILLUSTRATED COMIC BOOKLETS for adults (vest pocket size). The kind you like! 10 different booklets sent for 50c or 25 assorted for \$1. Shipped prepaid in plain wrapper. No C. O. D. orders. Send cash or money order. No stamps. GRAYCO, Dept. A-211, Box 520, G. P. O. New York

Make Your PAINT BRUSHES LAST!

How easy—with Dic-A-Doo Paint Brush Bath! Keeps *new* brushes soft, springy, flexible, ready for the next job. Restores *old* brushes to useful work. *All* the hard, caked paint dissolves. . . Buy 5¢ package, 10¢ box, at Paint Stores, Hardware Stores, Five and Ten Cent Stores. The Patent Cereals Co., Geneva, N. Y., makers of Dic-A-Doo Paint Cleaners.

DIC-A-DOO PAINT BRUSH BATH





WHERE ARE THEY NOW?

This is an Elastic Stop Nut.

There are more of them on America's planes, tanks, guns, and naval vessels than all other self-locking nuts combined.

The reason is an Elastic Stop Nut holds fast and locks tight without any extra locking gadgets.

It does this because of the elastic collar in the top.

This collar squeezes between the bolt threads. It grips both sides of the threads. So no amount of vibration shakes the nut loose.

You can take the nut off and put it back on, time and time again, and it still retains its locking effectiveness. This is because the collar is elastic and "comes back."

Billions of Elastic Stop Nuts are in use. And as far as we know, not one in a million has ever failed.

After a while, with the war won, you will be able to have these nuts with the characteristic red collar of ESNA on all the new equipment that will come. They will make it stronger, safer and more dependable just as they are doing on America's war goods today.

THE KIND OF JOB ELASTIC STOP NUTS ARE DOING

This is how the wing of a DC-3 transport plane is fastened on—with Elastic Stop Nuts, the nuts with the red collar so familiar to the aircraft industry. The tons of plane, crew and pay load depend on these nuts for their security. All told, this type of plane uses as many as 35,000 Elastic Stop Nuts.



ESNA

TRADE MARK OF

ELASTIC STOP NUT CORPORATION OF AMERICA

ELASTIC STOP NUTS

Lock fast to make things last

Union, New Jersey and Lincoln, Nebraska

He says can he
borrow some
Weldwood Glue!



You may never need to hold a life raft together with Weldwood Glue, but you'll find it's the handiest adhesive you ever used at your home work bench.

In fact, this easy-to-use plastic resin glue is a honey for hobbyists. Mixed just by adding tap water to the powder, it can be used immediately, is cold-setting (work can be handled in a few hours) and it makes a *permanent* bond!

Waterproof, rot-proof and bacteria-proof, Weldwood glue won't stain, or mar the most delicate color or finish.

Your hardware store or lumber dealer has handy packages of Weldwood Glue in 10¢, 25¢, 50¢ and 85¢ (1 lb.) sizes. Get a can today or send 25¢ and your dealer's name for a trial 3½ oz. sample. Supply limited, due to Uncle Sam's war needs.

UNITED STATES PLYWOOD CORPORATION

Weldwood Glue Dept. 58, 55 West 44th Street, New York 18, N. Y.

Weldwood Glue has everything:

1. Tremendous Strength.
2. Waterproof, Bacteria- and Rot-proof.
3. Quick and Easy to use. No heating. No waiting.
4. Economical.
5. Applied Cold, quick setting.
6. Stain-Free.



"Makes the glue line the **SAFETY line**"



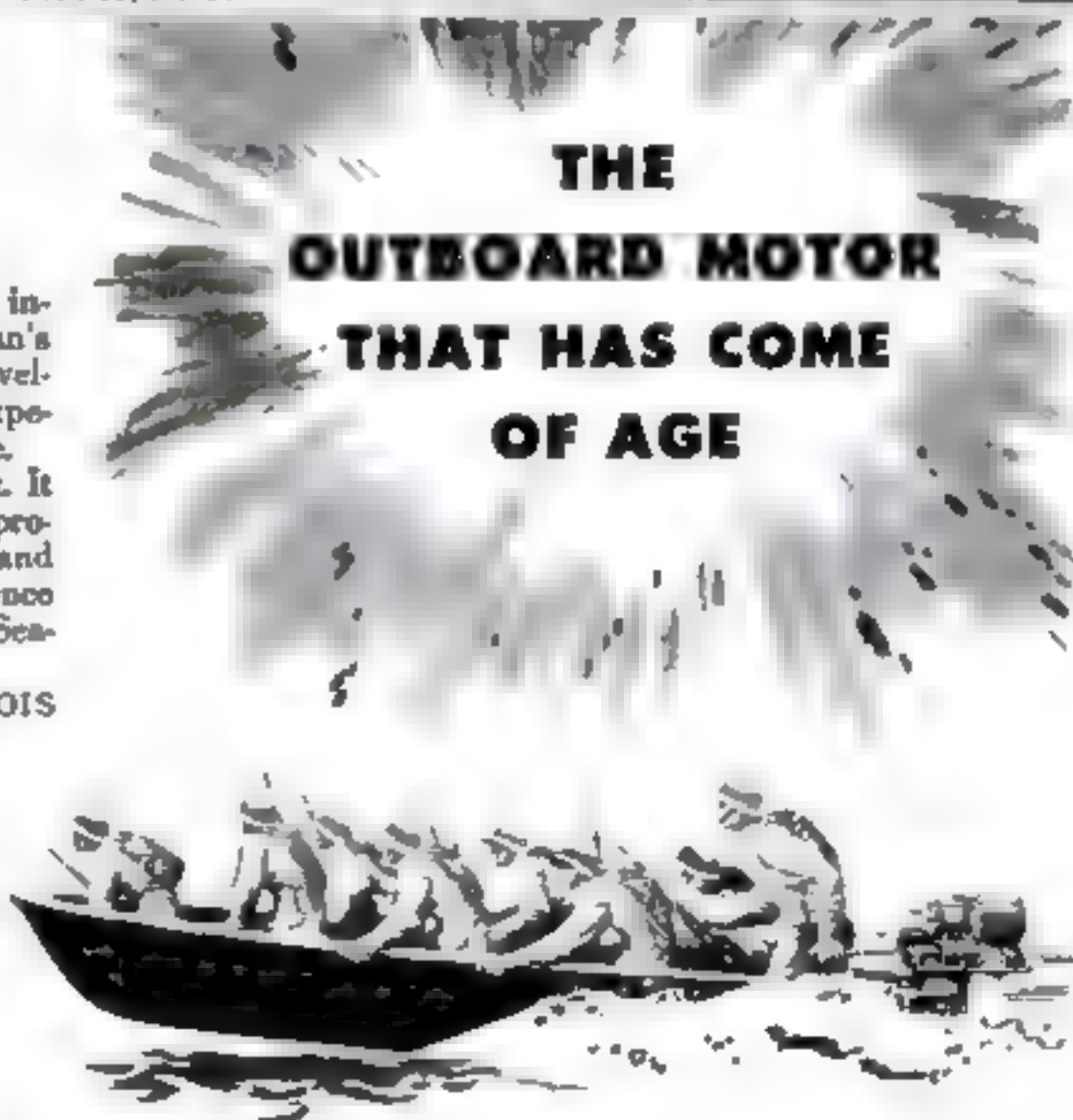
In the last war, outboard motors were in their infancy. Today Johnson Sea-Horses are doing man's work in the armed services. It took lots of development to bring them along so far...lots of experience in outboard design, metals, manufacture.

Johnson has this experience—22 years of it. It is being put to good use in a full schedule of production of Sea-Horses for the armed services and essential needs. It will be an even richer experience when it is again turned to the production of Sea-Horses for pleasure use.

JOHNSON MOTORS, WAUKEGAN, ILLINOIS

DO YOUR DUTY • BUY WAR BONDS

JOHNSON
SEA-HORSES
for DEPENDability



THERE IS NO SUBSTITUTE

FOR EXPERIENCE

Ingenious New Technical Methods

Presented in the hope that they will
prove interesting and useful to you.



New Saw-Gun Saws and Files in Hard-to-Get-At Places

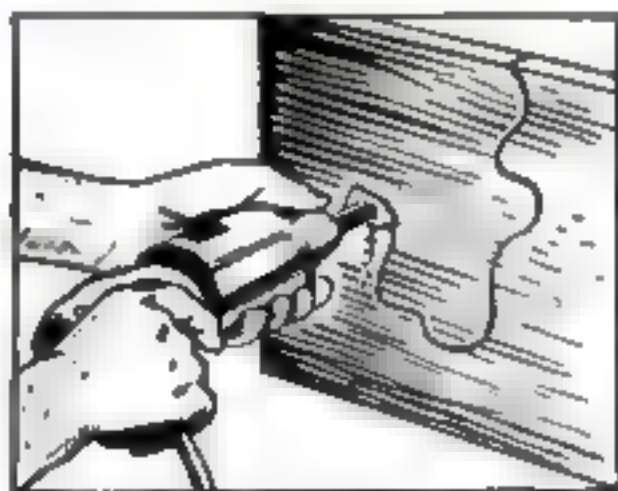
Jobs of sawing and cutting that are inaccessible to ordinary tools, are now made possible with the recently developed Saw-Gun. It works equally well on wood, plastics, light and heavy gauge metals (corrugated or plain—stainless and monel), castings, rods and other materials. The Saw-Gun saves hours on panel notching and slotting operations, doing work ordinarily requiring the use of several tools.

It is propelled by electric power, compressed air or flexible shaft and provides an efficient portable power-saw or file, that can be carried from place to place.

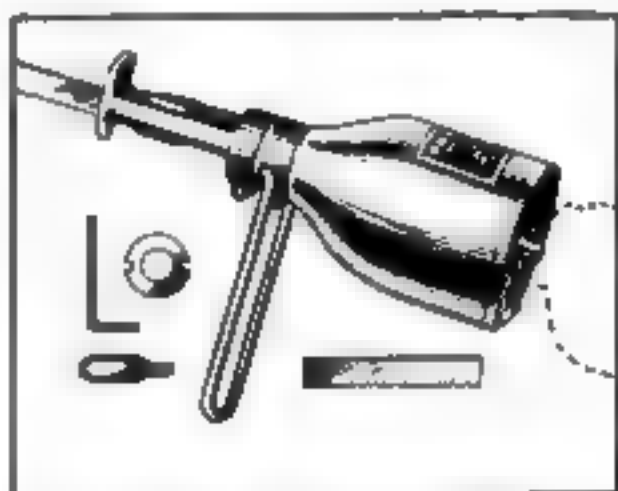
The Saw-Gun is operated by placing cutting edge of saw blade against work and turning on power. Filing is accomplished in the same manner by inserting a file in the tool instead of a saw blade.

We hope this has proved interesting and useful to you, just as Wrigley's Spearmint Gum is proving useful to millions of people (much to their surprise) working everywhere for Victory.

*You can get complete information from the Mid-States
Equipment Co., 2429 S. Michigan Ave., Chicago 16, Ill.*



Permits sawing and filing in spots
inaccessible to ordinary tools.



Can be directly connected to electric
drill, air drill, or flexible shaft.

Y-108

MICRO-TESTING
"beats the promise"
FOR
CLEANER SHAVES!

PROFESSIONAL Blades embody a degree of precision superior to usual high standards. Tolerances so close to perfection—attained by PROFESSIONAL craftsmen—are your guarantee of cleaner, smoother, more satisfying shaves. Try PROFESSIONAL Blades today—they're a new shave sensation. More shaves per blade assure savings for you—and reserve more steel for the war effort. At your local dealer.

Professional

PRECISION-MADE ★ RUST-RESISTANT

BLADES

**FIVE
BLADES
for
25c**

PROFESSIONAL BLADE CO.,
 NEWARK, 2, NEW JERSEY

Blatz Beer

*Never sharp...
 Never bitter...
 Always mellow...
 Good Taste*

MILWAUKEE'S
 MOST EXQUISITE BEER



Fast Becoming
 AMERICA'S
 NEW
 FAVORITE

Blatz Brewing Co., Milwaukee, Wis.
 In our 93rd year

BUY WAR BONDS



THE HOW AND WHY OF

DATA ON WILLIAMS' CUTTING-OFF TOOL HOLDERS (Data Sheet No. 12)



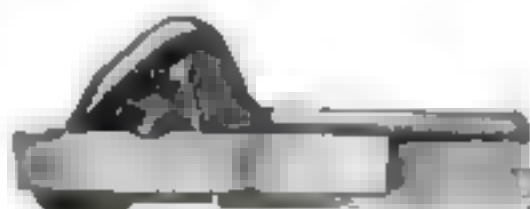
With Williams' Spring Cutting-Off Tool Holder, feed can be applied automatically leaving operator free to watch and thoroughly lubricate the work.

Williams' Spring Cutting-Off Tool Holder makes comparatively simple a lathe operation normally one of the most difficult. Several advantages result from the "goose-neck" design of this Holder which automatically provides relief from any sudden or excess pressure on the cutter blade. Even an inexperienced operator can cut off work considerably out-of-round without chatter, "climbing" or damage to either tool or work. The shock-absorbing qualities of this Spring Head, likewise, tend to protect lathe bearings and journals and will definitely improve the quality of work done on old and "loose" lathes. Only with this type of Spring Holder can the automatic cross feed be used for cutting-off operations.

In setting-up, the *spring* cutting-off tool should be set slightly above center. A *rigid* cutting-off tool, however, should always be set on exact center. See drawing at lower left. Cutters may be sharpened by grinding the end of the blade . . . usually to an angle of 5°. The sides of Williams' blades never need to be reground since they have sufficient taper throughout their length to provide side clearance. The work should be flooded with oil when cutting off steel. No lubricant is necessary with cast iron or non-ferrous metals.

Below are illustrated the two types of Williams' Cutting-Off Tool Holders. The rigid Holder accommodates either a cutting-off or side blade without any adjustment. Its cutting-off blade is interchangeable with Williams' Spring Holder. Both these types of Williams' Holders employ a positive cam lock to hold their blades in place, which is both quick-acting and rugged.

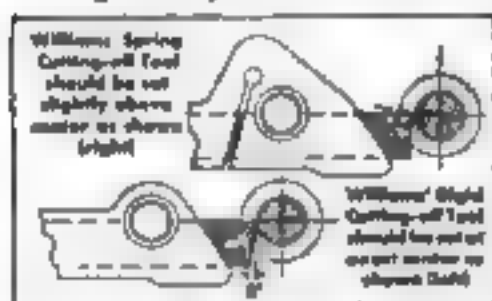
WILLIAMS' SPRING CUTTING-OFF HOLDER



Straight Shank Pattern. Also made with Right Hand Offset shank.

WILLIAMS' CUTTING-OFF & SIDE-TOOL HOLDER

Left Hand offset Pattern. Also made with Right Hand Offset and straight shank.



FREE DATA SHEETS

J. H. WILLIAMS & CO., BUFFALO 7, N. Y. ON USE OF SHOP AND HAND TOOLS

Your name and address in the margin below will bring 12 Tool Holder Data Sheets (punched for 3-ring binder) and a list of our complete Data Sheet series. Mail to above address, Dept. PS-4.



"Put an End to His Career Pronto"

"In Alaska, I bought a 30-30 Marlin Rifle, a real beauty. I say 'beauty' because up in that country a good gun is a very necessary piece of equipment.

"One morning I was coming home with a nice buck deer on my back. A big, hungry Brownie got the scent and was trailing me...finally caught up with me. That was the first big bear I had the misfortune to meet up with. I aimed for his forehead but, as I was scared stiff, I hit him in the front shoulder.

"He reared up, his big teeth bare, and snarling a plenty. A well-placed shot in his mouth put an end to his career pronto."

...Walter Nowalk,
Fort Stanton, N. M.

★ ★ ★

We do not recommend a 30-30 for Alaska brown bear, but are glad Mr. Nowalk's Marlin proved so accurate and dependable in this emergency. We do recommend Marlin 30-30's for deer, however, and can promise loyal Marlin users some new "beauties" after the war is won.

THE **Marlin** EST 1870 FIREARMS CO.
New Haven, Conn.

★ Turn in your old shells and cartridges to local scrap collection. Metal urgently needed for war production.



XCELITE

**SCREWDRIVERS
AND NUT DRIVERS**

"Designed for the Hands of Experts"

From the tip of the blades to the top of the handles, these tools represent the newest ideas in design. Real man-size handles are special plastic (the original transparent shock-proof Xcelite). Blades are high quality steel, expertly machined. Nut driver sockets deep enough to handle two nuts. Over 30 sizes and models of Xcelite Screwdrivers. 35 sizes of nut drivers (including Deluxe set of 7 with different colored handles for each size, supplied in sturdy metal container for wall mounting). All nut drivers and most sizes of screwdrivers can be furnished with fire-resistant handles at slightly higher prices. Ask your radio, electrical or hardware dealer—or write Dept. I.

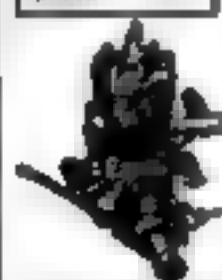
PARK METALWARE CO., Inc.
Orchard Park, N. Y.

WHEN YOU
BUY TOOLS

Specify **XCELITE**

Back The Attack. Buy More War Bonds

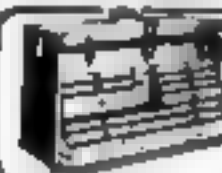
Complete \$20



ENGINES IN STOCK

The G. H. Q. miniature gasoline engine that really operates is still available. Over 100,000 sold to date. 1 1/2 H. P. Complete with flywheel and propeller, fuel, 15 accessories and full instructions. Fully bench tested and ready to run. For boats, planes, midget cars, etc. Send only \$1.00—Shipped Collect C. O. D. same day. Send 25c for illustrated Catalog of hundreds of hobby items.

G. H. Q. MOTORS, Dept. 5V, 48 East 21 St., New York 10, N. Y.



GERSTNER Tool Chests

Only these Better Chests are good enough for the good tools of machinists and toolmakers. Free Catalog

GERSTNER TOOL CHESTS
544 Columbia St., Dayton 7, Ohio.

Thompson
BEATS
the World
in BOATS



**Better Built
Lower Prices**

Canoes \$75 and up

Rowboats \$48 and up

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Light "Car-Top" Boat

Safe Boats With Full Length Spray Rails

Keep passengers perfectly dry even at high speeds. Catalog also shows today's seven most popular models of sailboats. Two big factories. Prompt shipment.

Write for your copy. State kind of boat in which you are interested.

THOMPSON BROS. BOAT MFG. CO. (110)
219 Ann St. (Write to)
Pawtucket, R.I. (either place)

118 Elm St.
Cortland, N.Y.



"PLENTY RUGGED", say our fighting men, to sum up the tough jobs . . . to patly describe any grim task from long, forced march to furious battle action.

Rugged too are the assignments that Evinrudes are capably handling in every part of the world—from busy home ports to beachheads on distant fighting fronts.

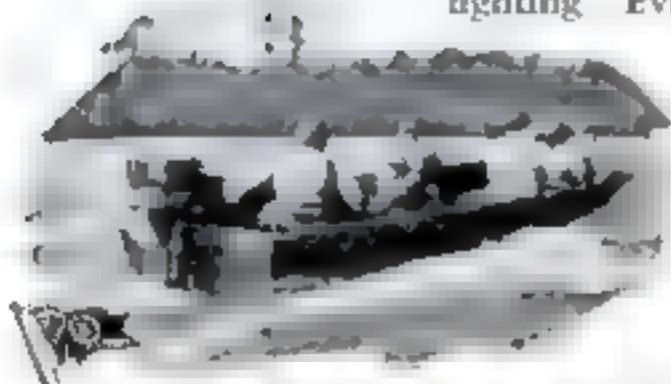
Powering lighters, ferries, tenders, work boats . . . many Evinrudes are rolling up operating records equal to several lifetimes of ordinary duty.

On assault craft, swift and powerful "fighting" Evinrudes have proved their

stamina on many fronts. Evinrudes serve with England's famed Commandos. Great Evinrude "fours," specially developed for the purpose, drive many of the Army's speedy Storm Boats.

Motors for such service . . . motors of many types for our fighting forces . . . are the only kind we are building now. Some day new peacetime Evinrudes will follow down the production line. You can be sure they will be tops for "rugged" service . . . and that in every other characteristic, they will be sheer pleasure to own!

EVINRUDE MOTORS, Milwaukee, Wisconsin



KEEP BACKING THE ATTACK
BUY MORE WAR BONDS

EVINRUDE

OUTBOARD MOTORS

How to

MAKE HAND SAWS LAST LONGER

See Your Hardware Dealer!



Tools are mighty important to the war effort. Your Hardware Dealer is cooperating with Uncle Sam by selling some types for essential uses only.

Perhaps you may not be able to purchase a new hand saw. Nevertheless, your Hardware Dealer *can* help.

If your old saw is a Disston—or other quality make—a good, inexpensive reconditioning job will put it in serviceable condition. See the Disston dealer in your community. Talk it over with him. At the same time he will tell you about the possibility of getting new tools for essential work.

Save your tools and serve your country. Fix 'em up and make 'em do!



HENRY DISSTON & SONS, INC.
410 Tacony, Philadelphia 35, Pa., U. S. A.



GOOD ADVICE AND PRACTICAL HELP on tool use and care are yours for the asking in the Disston Saw, Tool and File Manual. FREE from your Hardware Dealer, or write for a copy.

Cushman

BUY
BONDS



"The remarkable speed, stamina and convenience of CUSHMAN Auto Glides are helping win the battle of production!"—say scores of great war-time factories!

There's nothing like a CUSHMAN to break "delivery" bottle-necks! A CUSHMAN, and only one operator, replaces many foot messengers—delivers big loads of mail, repairs, etc.—carries inspectors, messengers, etc. It moves throughout the factory easier than other transportation. It speeds deliveries . . . cuts costs . . . saves manpower.

CUSHMAN Floating Drive applies power as smoothly as Fluid Drive. Eliminates clutch pedal, gear shift! Merely touch hand accelerator to start, travel any speed up to 35 mi. an hour. Flashy pick-up.

Knee-action with coil springs, long wheel base and balloon tires provide Smooth Riding. Low center of gravity, heavy brakes, excellent lights provide Safety.

WRITE The Army, Navy, Air Force and Many large war plants take a large part of our output. However, you also may be able to qualify. See your dealer or write us,

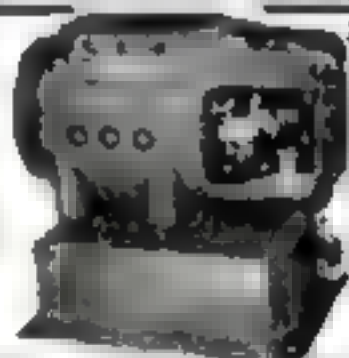
CUSHMAN MOTOR WORKS, Dept. M-3, Lincoln, Nebr.

110-VOLTS AC

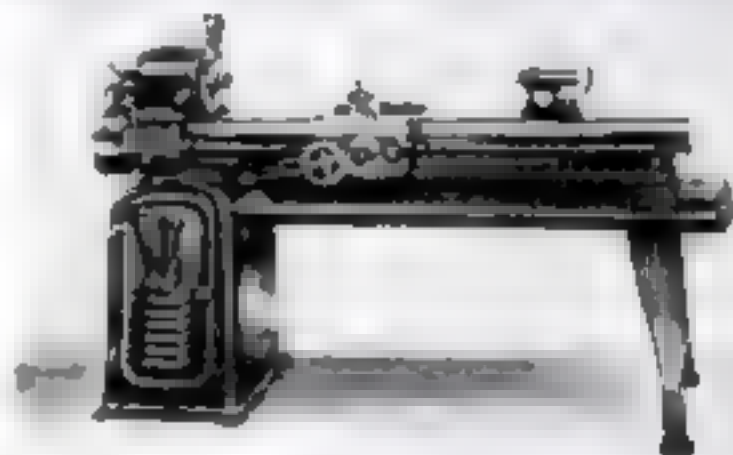
from DIRECT CURRENT

with KATO CONVERTERS. Furnish standard 110 v. AC from 30, 110 or 220 v. DC. Good deliveries on sizes 150 through 1500 watts on priority orders. Good deliveries on 5, 7 1/2, 10 & 25 KW AC generators. Mfg's of motor generators, frequency changers and high frequency generators.

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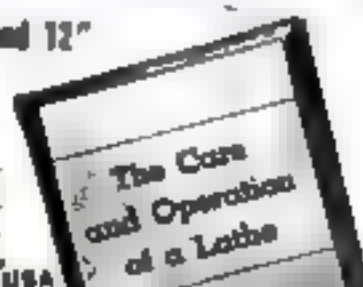
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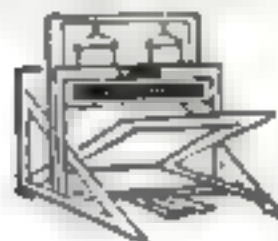
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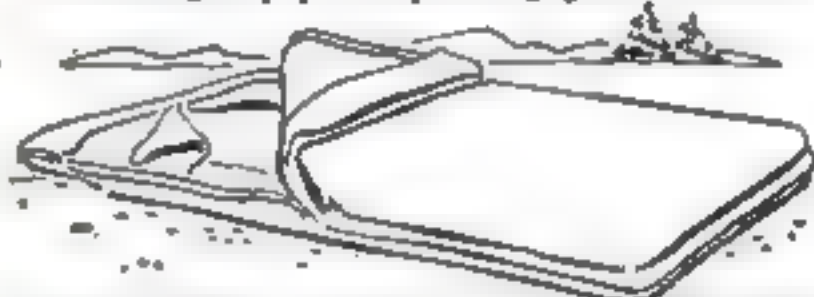
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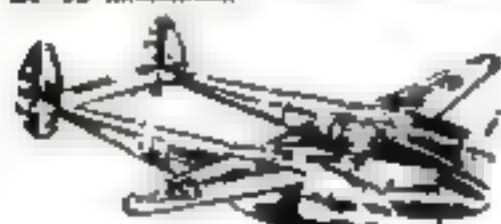
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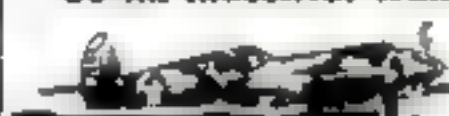
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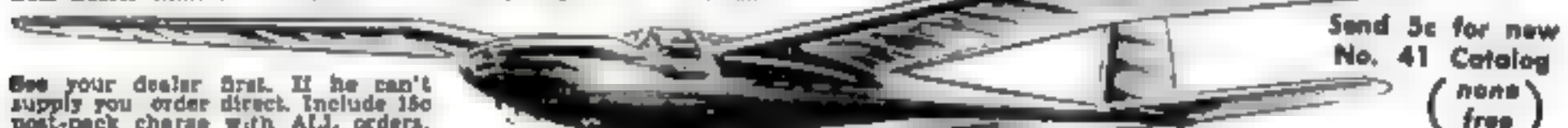


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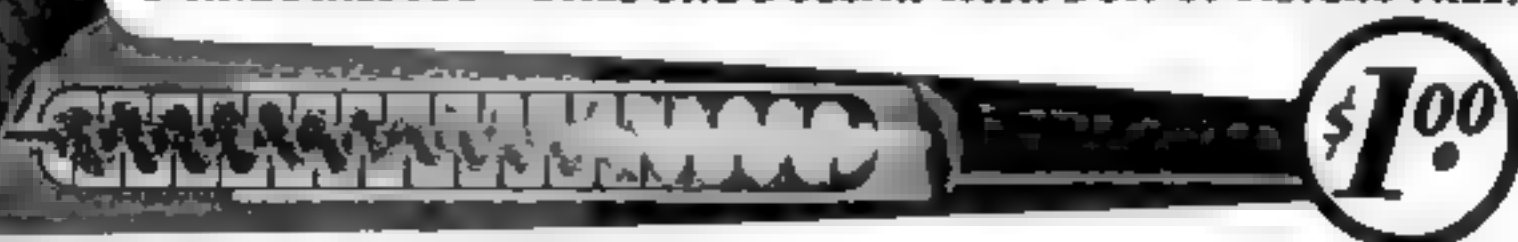


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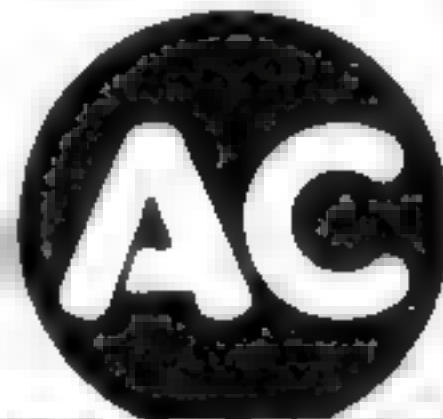
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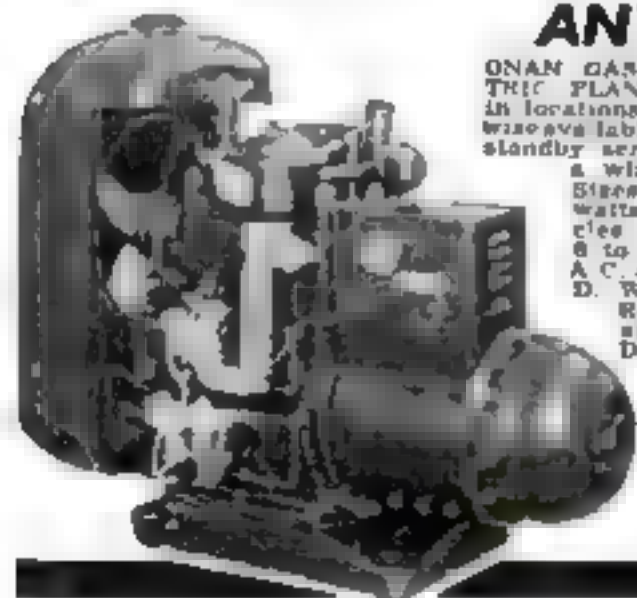


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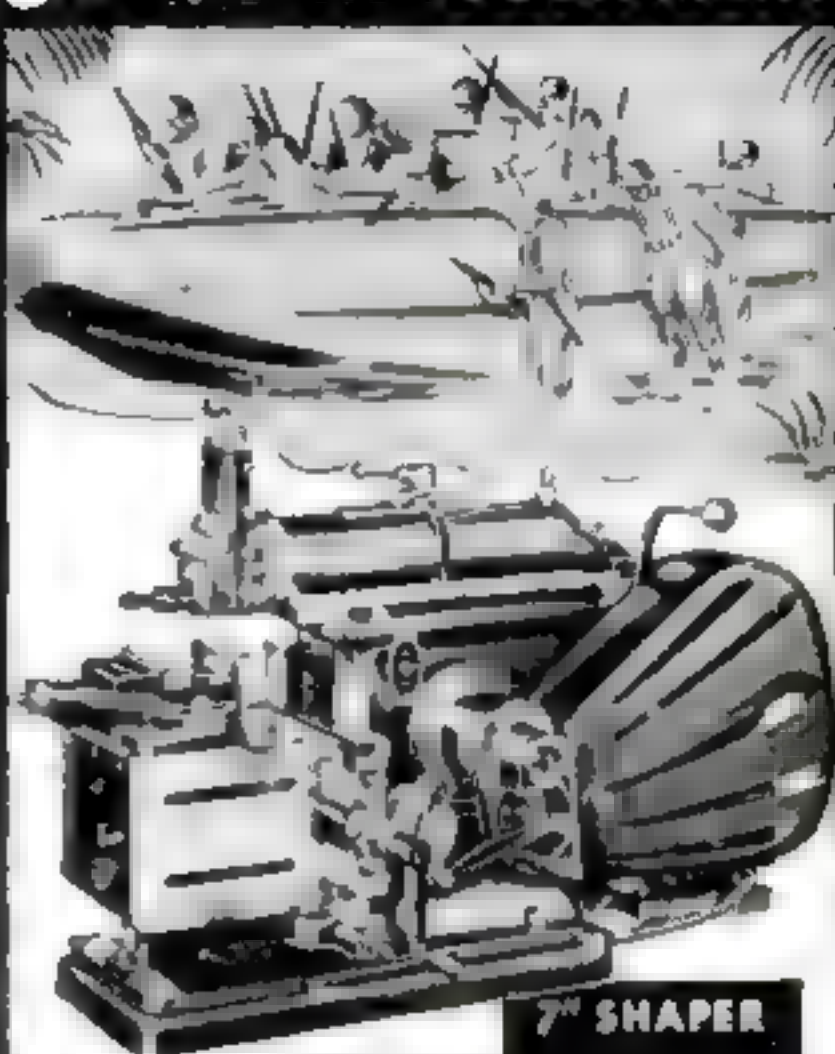
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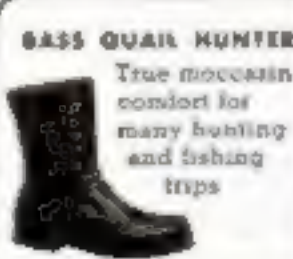
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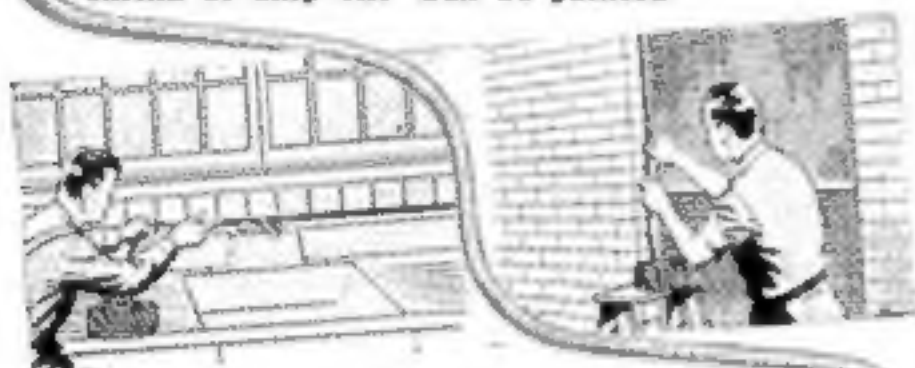
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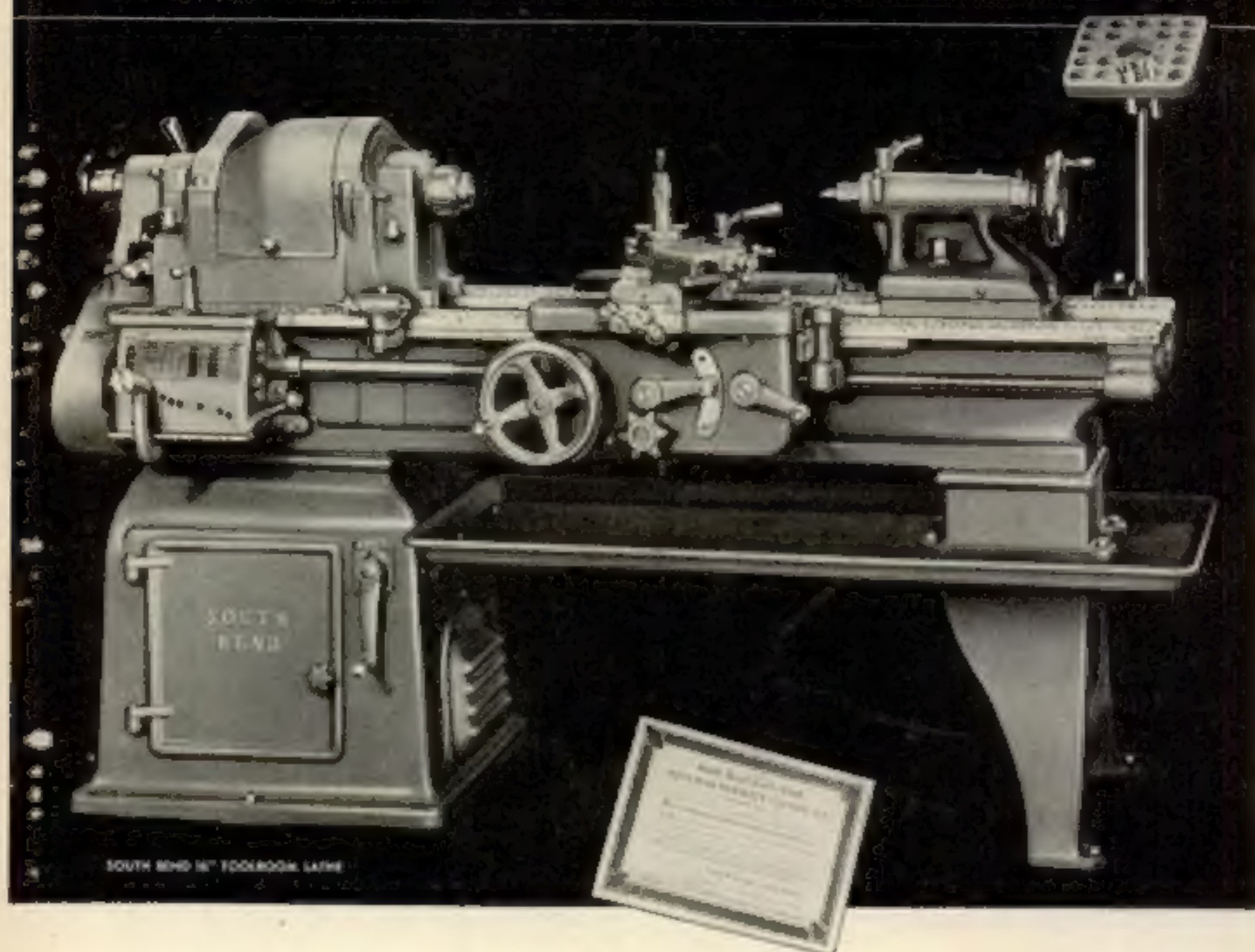
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